FLORA OF THE LOWER HEADON BEDS OF HAMPSHIRE AND THE ISLE OF WIGHT

BY

MARJORIE E. J. CHANDLER

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By M. E. J. CHANDLER

SYNOPSIS

The type section of the Lower Headon at Hordle, Hampshire, is briefly described and reference is made to the earlier work on the beds and their flora. The most varied collection of land plants comes from Bed 10 (the Leaf Bed) at Hordle especially east of Beckton Bunny and below Hordle House but gregarious water plants occur at a number of horizons. The mode of preservation of the fruits and seeds is noted. Twenty-seven species new to the flora are added and fifteen genera while some former erroneous generic records have been corrected. Four species formerly described as *Carpolithus* can now be placed in their systematic position. A few sparse records from the Lower Headon of the Isle of Wight are included.

INTRODUCTION

It is over thirty years since the Lower Headon flora of Hordle was studied during which time much new knowledge both of living and fossil material has been gained. The flora has been enriched by more collecting from the type locality at Hordle; there is also sparse material from other sites. Research on older Eocene floras of the South coast has shed fresh light on the relationship of some earlier erroneously determined genera and species so that mistakes have now been corrected. In view of the above considerations the revision of the Lower Headon flora is overdue and is attempted in the following pages.

As always, the author is deeply indebted to Dr. K. I. M. Chesters and Mr. F. M. Wonnacott for their invaluable help in the preparation of this paper.

EXPOSURES OF THE LOWER HEADON BEDS

Beds of Lower Headon age are exposed both on the mainland and in the Isle of Wight: on the mainland at Hordle cliff, near Milford-on-Sea, Hampshire and on the island on its north-western shores. The cliffs at Hordle, unlike most mainland sections at the present day, are still unobstructed by man-made obstacles to collecting although it is clear from the local anxiety about the present rapidity of coast erosion that this state of affairs cannot persist much longer. In the past the condition of the cliff has varied from year to year with major changes extending over long periods. Hence sometimes collecting has been carried out readily, while at other times the productive beds have been inaccessible if high up, or completely masked by scree when low down. In the Isle of Wight a few plants only have yet been found for no rich horizons or pockets with remains of land plants like those of Hordle Bed 10 have so far been discovered.

1. HORDLE

Towards the end of the marine episode represented by the Barton Beds of Barton cliffs recession of the sea was again taking place. As a result the truly marine Barton clays pass gradually through transition beds (the Long Mead End Beds) into the estuarine and fluviatile deposits of the Lower Headon. The land surface must now have extended much further east than during the deposition of the Barton Beds but appears still to have been drained by a now much lengthened river flowing from the west. The variable clays, current bedded sands and lignitic seams of the Lower Headon were laid down by the river which at certain horizons left remains of the plants growing upon its banks in the sediments. These plants are represented by fruits, seeds and battered leaves. At some stages the only plants preserved were the monotonous remains of gregarious genera and species of the aquatic or subaquatic vegetation, e.g. *Chara*, *Limnocarpus*, *Stratiotes* and *Brasenia*, which may be presumed to have grown in brackish lagoons and delta channels in view of their association with estuarine shells.

The most detailed accounts of the Hordle cliff section were those by the Marchioness of Hastings (1852 : 191) and Tawney & Keeping (1883 : 566). During the years 1920–25 the author carried out continuous observation of the section and, as a result, the strata were tabulated so as to show the connexion between these earlier records and the beds then exposed (Chandler, 1925 : 3). With the exception of *Chara*, *Sequoia*, *Limnocarpus*, *Stratiotes*, *Brasenia*, *Rhamnospermum* and rare *Caricoidea* and *Spirematospermum* the plant remains have all been derived from two or three stations at a single horizon named by Tawney & Keeping the Leaf Bed or Bed 10. Because of the action of the sea and the fall of talus, the chance of collecting from a good exposure has been known to change even during a single tide. Thus E. M. Reid related in 1920 how on one occasion she and Clement Reid found abundant remains of *Acrostichum lanzaeanum* exposed in the cliff base and foreshore below Hordle House (now Hordle House School). By the next day the exposure had been completely hidden by a cliff fall. Bed 10 is very variable in character. It consists of sands, clays, lignites and cement stone of limited extent, all of which may yield plants sometimes sparsely disseminated, sometimes concentrated in lenticles or pockets. Its first appearance in the west is at the top of the cliff near Beckton Bunny. Passing eastwards it dips gradually until it reaches beach level a short distance to the east of Hordle House, where it forms the base of the cliff and adjacent foreshore and is about 8 feet thick. Between 1926 and 1931 a magnificent section was exposed in this position by the scouring of the talus from the cliff foot and the shingle from the beach. The constant cutting of the sea into the bed produced a succession of fresh surfaces. Grey tenacious well-bedded clay formed the cliff base and upper foreshore with some interbedded sands. A hard mudstone or cement stone about two inches thick extended laterally for some distance in the foreshore about two feet above the underlying Mammal Bed (green clays with pockets of *Paludina* also well exposed at this time in the lower part of the foreshore). Soft strata immediately overlying the mudstone yielded fragmentary leaf-remains disposed irregularly without reference to bedding planes, the leaves being mangled, twisted and decayed. The carbonaceous films of leaf tissue disintegrated immedi-

ately on exposure to dry air, no cuticle having been preserved as in the leaves from Bournemouth or the Hordle *Sequoia* twigs. Hence only impressions are found in old collections and those are liable to be very imperfect on account of the soft matrix. By splitting blocks a number of specimens of *Salvinia* were found. These became hard on drying as often happens when soft strata have been exposed to the action of salt water. In the hardened state the reddish matrix resembles that of the palm leaf (*Nipa*) impressions in the Sedgwick Museum, Cambridge. It therefore seems probable that the palms came from this part of the section. The plants collected from Bed 10 below Hordle House were chiefly representative of a limited freshwater or subaquatic plant-formation. The most abundant genera were *Salvinia, Brasenia, Stratiotes* and *Limnocarpus*. The few fruits of *Spirematospermum* now referred to a new species, *S. headonense*, were from this site. The occasional patches of *Acrostichum* and (probably from here) of *Nipa* indicate brackish conditions and tropical coastal marshes. The matted occurrence of the *Acrostichum* pinnules here as in the Dorset Pipe-clay Series suggests that it grew where it was preserved, the fronds falling continually into the mud by which they were buried. Land plants were sparse below Hordle House but a few were found by Clement Reid. A small stoned *Rubus* and *Sambucus* were abundant. There were also Icacinaceae and *Zanthoxylum* and a seed of Cucurbitaceae. It is a handicap to further research that at present tons of talus from the overlying Headon and Pleistocene beds obscure this part of the cliff while the foreshore is deeply buried under beach gravel. It may be many years, if ever, before collecting is again possible below Hordle House.

Concentrations of plants have also been seen from time to time in Bed 10 at other parts of the cliff section. A band rich in seeds and twigs of *Sequoia couttsiae* was long exposed east of Taddiford (= Long Mead End) and was accessible a few feet above the beach. It was made conspicuous both by the purplish tinge of its clays and sands and by a bright yellow efflorescence on the surface due to pyrites. There were also plant pockets high up in the cliff between Beckton Bunny and Taddiford but it was necessary to exercise the greatest caution in approaching them owing to the softness of the sands and clays which produce treacherous deep mud flows. Certainly since 1920 and until recent years a most productive lenticle was available near the cliff top a few yards east of Beckton Bunny. Here the richest matrix was coarse purplish sands underlying a few feet of well laminated tenacious purplish-grey clay beneath the Pleistocene gravels. This bed, from six to twelve inches thick, rapidly thinned and finally died out eastwards. In a westerly direction it was cut out altogether by the sloping sides of the stream at Beckton Bunny. The bed yielded remains of trees, shrubs and woody climbers all of which may be presumed to have grown upon the river banks. Endocarps of Mastixioideae, represented especially by two genera, were particularly abundant and could be picked out of the weathered surface in handfuls. The loose sandy matrix was readily sifted on the spot without boiling thus reducing the bulk to be carried home for examination. Water plants occurred more sparsely than land plants.

Towards Taddiford Bed 10 has always been obliterated by a contemporary stream channel cut transverse to the cliff face. The channel is rendered conspicuous by

the immense amount of black carbonaceous detritus and masses of broken woody fragments. It did not yield a sufficient quantity of fruits and seeds to be worth working extensively but two good endocarps of *Natsiatum eocenicum* were picked up on rain-washed slopes of talus and there were also *Sequoia* seeds and much abraded fruiting heads of *Protoaltingia hantonensis* formerly referred to *Liquidambar* sp. (Chandler, 1925 : 25, pl. 4, fig. 1).

The Lower Headon fruits and seeds are carbonaceous entities. When first extracted from the cliff they appear as unshrunken and undistorted beautifully preserved specimens scarcely distinguishable except by colour and differences of specific character from their living counterparts. Thanks to the soft carbonaceous and uncrushed condition they are easily dissected so that they afford invaluable evidence about their internal characters. Natural fractures and dissections of such material give readily available information for comparison with broken surfaces in living material. There is always considerable shrinkage of carbonaceous material on drying e.g. large endocarps of *Mastixicarpum* (Mastixioideae) may lose from half to three-quarters of their length in this way. Dried specimens also tend to become distorted and the coarse sandy matrix causes pitting of both external and internal surfaces in some specimens while sand grains may have penetrated along cracks, natural canals and planes of weakness like the edges of valves, filling locule- and seed-cavities and often pock-marking the lining membranes. Testas inside woody endocarps, or tegmens in the case of seeds, are commonly present as tough readily detachable skins. As so frequently happens in carbonaceous material pyrites disseminated throughout the tissues renders them liable to disruption and decay. The softness of the carbonaceous substance may also give rise to crumbling although in both cases deterioration may be delayed by treatment with paraffin wax. Hence the importance of adequate photographic records of the specimens showing range of variation and characteristic features.

The first account of the Hordle flora (Chandler, 1925, 1926) was based on collections by C. & E. M. Reid and by M. E. J. Chandler. A few specimens in the Sedgwick Museum, Cambridge and in the British Museum (Natural History) were also examined. Since that time, in 1939 and 1940, the slope of the cliff near Beckton Bunny made Bed 10 particularly easy to work. Every visit produced valuable material, much being new, and some twenty-seven additions to the published flora were then made. In June 1940 national defence restrictions made further field work impossible and when the coast was once again open in 1945 the cliff was in an unfavourable condition for collecting.

The following are additions to the flora : *Stratiotes hantonensis* Chandler, *Caricoidea obscura* Chandler, *Scleria hordwellensis* n. sp., *Myrica boveyana* (Heer), *Carpinus boveyanus* (Heer), *Moroidea hordwellensis* n. sp., *Becktonia hantonensis* n. sp., *Hantsia glabra* n. sp., Lauraceae Genus ?, *Eoliquidambar hordwellensis* n. sp., Leguminosae (two unidentified genera), *Palaeobursera lakensis* Chandler, *Iodes ? hordwellensis* n. sp., *Icacinicarya transversalis* n. sp , *Icacinicarya becktonensis* n. sp., *Frangula hordwellensis* n. sp., *Meliosma* sp., *Actinidia* sp., *Cleyera ? stigmosa* (Ludwig), *Anneslea ? costata* n. sp., *Eurya becktonensis* n. sp., Thymeliaceae Genus ? *Microdiptera parva* Chandler, *Cornus quadrilocularis* Chandler, *Olea headonensis* n. sp., ? *Acanthus* sp.

Not only have new species been found since the original monograph was published but fresh knowledge both of Recent and fossil material has enabled certain mistakes to be corrected. Just as initially the Hordle flora helped in the understanding of other Tertiary floras examined later, so, too, these other older floras have in their turn shed new light on that of Hordle. Thus it is now possible to place in their proper botanical positions over a dozen species which were before incorrectly named. The following corrections may be noted: *Salvinia hantoniensis* (Chandler, 1925 : 10, pl. 1, fig. 1*a–d* ; text-fig. 1) has been referred by Shaparenko (1956) to *S. mildeana* Goeppert. *Cladium minimum* (Chandler, 1925 : 14, pl. 1, fig. 5*a*, *b*) is now referred to the form-genus *Caricoidea* denoting relationship with Caricoideae rather than with *Cladium* itself. *Limnocarpus headonensis* (Chandler, 1925 : 13, pl. 1, fig. 4*a–c* ; text-fig. 3) becomes *L. forbesi* (Heer) for reasons given by Chandler 1961*a*. *Campylospermum hordwellense* (Chandler, 1925 : 16, pl. 1, fig. 6*a–c* ; text-fig. 4) formerly referred to Araceae, belongs to the Theaceae, section Taonabeae, although no identical living genus has yet been found. *Nuphar ovatum* (Chandler, 1925 : 22, pl. 3, fig. 3*a*, *b*) thanks to the work of Docturowsky, Nikitin and Korzhinsky becomes *Aldrovandra ovata* (Droseraceae) (see Reid & Chandler, 1926 : 111–114, pl. 6, figs. 24–29). *Menispermum obliquatum* (Chandler, 1925 : 24, pl. 3, fig. 9*a*, *b*) is transferred to the fossil genus *Palaeosinomenium* (Chandler, 1961 : 159). *Rhamnospermum bilobatum* (Chandler, 1925 : 30 ; 1926, pl. 5, fig. 1*a–c* ; text-fig. 13) cannot be retained in Rhamnaceae although its relationship is obscure. It has been found now at horizons ranging from the Lower Bagshot to the Hamstead Beds and there is a new and unpublished record from the London Clay. Rhamnaceae Genus ? sp. 2 (Chandler, 1925 : 31 ; 1926, pl. 5, fig. 2) is now referred to *Frangula hordwellensis*. *Corydalis pulchra* (Chandler, 1925 : 25, pl. 3, fig. 10*a*, *b*) must be removed from *Corydalis* and the family Papaveraceae and placed in Caryophyllaceae under a new generic name *Hantsia* for reasons given on p. 114. *Liquidambar* sp. (Chandler, 1925 : 25, pl. 4, fig. 1) is actually *Protoaltingia hantonensis* common in the older Tertiary Beds of the Dorset and Hampshire coast section as shown by the abraded remains of the fruits with antero-posterior locules and both loculicidal and septicidal dehiscence. *Zanthoxylum ornatum* (Chandler, 1925 : 27, pl. 4, fig. 4*a*, *b* ; text-fig. 10) is removed from the living genus and placed in a form-genus *Rutaspermum* Chandler. *Actinidia crassisperma* (Chandler, 1926 : 34, pl. 6, fig. 2 ; text-fig. 15) is referred to a new genus *Hordwellia* of the family Theaceae, section Taonabeae. *Carpolithus* sp. 2 (Chandler, 1926 : 44, pl. 7, fig. 12*a–d* ; text-fig. 28) belongs to the Mastixioideae and probably to *Mastixia*. It resembles *Retinomastixia* Kirchheimer in the numerous resin-cavities in the wall and is named *Mastixia? glandulosa*. *Eomastixia bilocularis* (Chandler 1926 : 37, pl. 6, fig. 6*a–e* ; text-fig. 20) has to be placed in Zenker's species *E. rugosa*. Ericaceae Genus ? (Chandler, 1926 : 37, pl. 6, fig. 7*a*, *b*) is Epacridaceae and is described under a form-genus *Epacridicarpum*. *Symplocoides glandulosa* (Chandler, 1926 : 41, pl. 7, fig. 5*a*, *b* ; text-fig. 26) and *Carpolithus* sp. 3 (Chandler, 1926 : 45, pl. 8, fig. 1*a–e*) both belong to Cornaceae and are now referred to *Dunstania*, a genus from the London Clay which, according to Kirchheimer should itself be placed in *Cornus*. *Carpolithus* sp. 4 (Chandler, 1926 : 45, pl. 8, fig. 2*a*, *b*) is referred to *Cornus quadrilocularis* Chandler. Oleaceae Genus ?

(Chandler, 1926 : 42, pl. 7, fig. 7 ; text-fig. 27) appears to be *Olea* and is named *O. headonensis*. *Omphalodes platycarpa* (Chandler, 1926 : 42, pl. 7, fig. 8*a*, *b*) needs confirmation from additional material but no alternative suggestion as to its relationship can at present be made. *Orites* sp. (Chandler, 1926 : 47, pl. 8, fig. 6) : better evidence as to structure and some in regard to the seeds is needed. The fruit spike shows some of the characters of *Carpolithus gardneri* Chandler (see p. 154) ; its relationship still awaits discovery. *Atriplex* sp. (Chandler, 1925 : 21, pl. 3, fig. 2) must be deleted. Further study reveals that it is an accidental Recent inclusion. *Carpolithus* sp. 5 (Chandler, 1926 : 46, pl. 8, fig. 3*a–d*) is referred to Mastixioideae Genus ?

The invaluable detailed studies by Kirchheimer of well-preserved Brown Coal material confirms the reference of *Spirematospermum* to the Zingiberaceae but a consideration of his published evidence necessitates placing the Lower Headon fruits and seeds in a distinct species now named *S. headonense* (p. 108).

The full up-to-date list of Lower Headon plants omitting the Charophyta (described by Reid & Groves in 1921) is given below. All come from Bed 10, just east of Beckton Bunny unless otherwise stated in the systematic description. The numbers by which the beds are designated are those used by Tawney & Keeping (1883) and repeated by Chandler (1925 : 3). Bed 10 has been referred to by C. Reid and by Chandler as the Leaf Bed, Bed 29 as the *Chara* Bed and Bed 31 as the *Limnocarpus* Band of the *Unio* Bed.

In several cases where no new material is available and there is nothing fresh to add to previously published work the registration number in the British Museum (Natural History) is added opposite the name. Where material is no longer extant this is indicated by the word Decayed.

Erdtmann (1960) gave a brief account with figures of three new pollen genera from the *Chara* Bed of Hordle cliff (erroneously said to be in Berkshire). As however a larger work on pollen from the Headon Beds is in preparation by Miss J. Pallot it is left to her to discuss the significance of these determinations. The importance of the discovery of a number of the Hordle plants at other older horizons will be discussed later when work on Eocene floras is surveyed. It is sufficient now to reaffirm that the flora is of tropical [Poltavian] type as indicated by the presence of *Acrostichum*, *Nipa*, Burseraceae, Icacinaceae and Mastixioideae. Associated animal remains also indicate a warm climate, among them are *Trionyx*, *Emys* and *Crocodilus hastingsiae*. There is a rich but little known fish and mammalian element. Among the former *Lepidosteus* scales and *Myliobates* are frequent (see Marchioness of Hastings, 1852 ; Tawney & Keeping, 1883). There are forty-three plant families, at least sixty-seven different genera and eighty-seven named or at least distinctive species.

2. COLWELL

Little collecting has been carried out in the Lower Headon of the Isle of Wight. A few plants only were obtained in the coast section between Colwell and Totland from the *Limnocarpus* Band, a readily recognizable horizon in spite of the fact that it is only a few inches thick. This distinctive band was formerly well exposed at

List of Lower Headon Plants

C, also at Colwell Bay, Isle of Wight. D, also at Downton, Hordle.

Family	Genus and species
Filicales	
Polypodiaceae	*Acrostichum lanzaeanum* (Visiani).
Salviniaceae	*Salvinia mildeana* Goeppert.
Gymnospermae	
Taxodineae	*Sequoia couttsiae* Heer.
Abietineae	*Pinus* sp. (Decayed.)
Angiospermae	
Monocotyledones	
Potamogetonaceae	*Potamogeton pygmaeus* Chandler (C).
	Limnocarpus forbesi (Heer) (C, D).
Hydrocharitaceae	*Stratiotes headonensis* Chandler (C).
	Stratiotes hantonensis Chandler.
Cyperaceae	*Caricoidea minima* (Chandler).
	Caricoidea obscura Chandler.
	Scleria hordwellensis n. sp.
	Genus ?
Nipaceae	? *Nipa* sp. (leaves probably of *N. burtini*).
Araceae	Genus ? (V.20036).
Zingiberaceae	*Spirematospermum headonense* n. sp.
Dicotyledones	
Myricaceae	*Myrica boveyana* (Heer).
Betulaceae	*Carpinus boveyanus* (Heer).
Moraceae	*Chlorophora bicarinata* Chandler. (Decayed.)
	Broussonetia rugosa Chandler.
	Moroidea hordwellensis n. sp.
	Becktonia hantonensis n. gen. & sp.
Caryophyllaceae	*Hantsia pulchra* (Chandler).
	Hantsia glabra n. sp.
Nymphaeaceae	*Brasenia ovula* (Brongniart) (C).
	Brasenia spinosa Chandler (includes *B. antiqua* Chandler).
	Brasenia oblonga Chandler.
Menispermaceae	*Palaeosinomenium obliquatum* (Chandler).
Lauraceae	Genus ?
Droseraceae	*Aldrovanda ovata* (Chandler) (C).
Hamamelidaceae	*Eoliquidambar hordwellensis* n. gen. & sp.
	Protoaltingia hantonensis Chandler.
Rosaceae	*Rubus acutiformis* Chandler.
Leguminosae ?	Genus ?
	Genus ?
Rutaceae	*Zanthoxylum hordwellense* n. sp.
	Zanthoxylum compressum Chandler.
	Phellodendron costatum Chandler.
	Rutaspermum ornatum (Chandler).
Burseraceae	*Palaeobursera lakensis* Chandler.
Anacardiaceae	
Spondieae	Genus ?

Family	Genus and species
Icacinaceae	*Natsiatum eocenicum* Chandler.
	? *Iodes* sp. (or ? *Natsiatum* sp.).
	Iodes ? hordwellensis n. sp.
	Icacinicarya transversalis n. sp.
	Icacinicarya becktonensis n. sp.
Rhamnaceae	*Frangula hordwellensis* n. sp.
Sabiaceae	*Meliosma* sp.
Vitaceae	*Parthenocissus hordwellensis* n. sp.
	Vitis uncinata Chandler (V.20065).
	Ampelopsis rotundata Chandler.
	Tetrastigma lobata Chandler. (Decayed.)
Dilleniaceae	*Actinidia* sp.
Theaceae	
Theae	*Gordonia minima* Chandler.
	Gordonia truncata Chandler.
Taonabeae	*Eurya becktonensis* n. sp.
	Campylospermum hordwellense Chandler.
	Cleyera ? stigmosa (Ludwig).
	Anneslea ? costata n. sp.
	Hordwellia crassisperma (Chandler).
Thymeliaceae	Genus ?
Lythraceae	*Microdiptera parva* Chandler.
Cornaceae	
Mastixioideae	*Eomastixia rugosa* (Zenker).
	Mastixicarpum crassum Chandler.
	Mastixia ? glandulosa n. sp.
	Genus ?
Cornoideae	*Cornus quadrilocularis* Chandler.
	Dunstania glandulosa (Chandler).
Ericaceae	
Andromedeae	Genus ?
Rhododendroideae	Genus ? (Decayed.)
Epacridaceae	*Epacridicarpum headonense* Chandler.
Ebenaceae	*Diospyros headonensis* Chandler.
Symplocaceae	*Symplocos headonensis* Chandler.
	Symplocos sp.
Styracaceae	*Styrax elegans* Chandler.
Oleaceae	*Olea headonensis* n. sp.
Boraginaceae	*Omphalodes platycarpa* Chandler.
Acanthaceae	? *Acanthus* sp.
Caprifoliaceae	*Sambucus parvulus* Chandler.
Cucurbitaceae	*Cucurbitospermum reidii* n. sp.
Family ?	*Rhamnospermum bilobatum* Chandler.
	Carpolithus fibrosus n. sp.
	Carpolithus apocyniformis n. sp.
	Carpolithus sp. 8.
	Carpolithus sp. 6. (V.20107).
	Carpolithus sp. cf. *C. gardneri*
	Carpolithus sp. 1.
	Carpolithus spp.
	and tubers, rhizomes (V.20111 and V.40182–83 " *Nelumbium buchii* Ettingshausen "), placentas.

Paddy's Gap, Milford-on-Sea on the mainland. Wherever seen it is a conspicuous feature owing to a compacted mass of white shells—*Paludina, Melania* and fragments of *Unio*—which show up conspicuously the black dots due to crowded endocarps of *Limnocarpus* together with seeds of *Brasenia* and *Stratiotes*. The *Limnocarpus* Band is part of the Hordle Bed 31 of Tawney & Keeping.

A few specimens labelled *Limnocarpus* Band were collected at Colwell by James Groves with whom Clement Reid worked in the field while in retirement at Milford-on-Sea. A few others merely labelled Colwell Bay were in the Reid Collection. No distinctive Upper Headon fruits are among them and it therefore seems probable that these also were from the *Limnocarpus* Band.

A section given on pp. 132–133 of the Geological Survey Memoir on the Isle of Wight (1889) records a number of seams with lignite and seeds but experience suggests that these seeds were the usual *Brasenia, Stratiotes* and *Limnocarpus*. Nevertheless there is always a possibility that some rich pocket like those of Bed 10, Hordle, may someday reward persistent search. So far, however, despite the vigilance of Groves and Colenutt no such has been discovered in the Isle of Wight.

The short list of plants from the Lower Headon of Colwell is as follows :

Potamogeton pygmaeus Chandler
Limnocarpus forbesi (Gardner)
Stratiotes headonensis Chandler
Brasenia ovula (Brongniart)
Aldrovanda ovata (Chandler)
} all are water plants.

PTERIDOPHYTA

Order FILICALES

Family POLYPODIACEAE

Genus *ACROSTICHUM* Linnaeus

Acrostichum lanzaeanum (Visiani)

(Pl. 24, fig. 2)

1858. *Fortisia lanzaeana* Visiani, p. 431, pl. 1, fig. 8, pl. 2, figs. 1, 5.
1879. *Chrysodium lanzaeanum* (Vis.) : Gardner & Ettingshausen, p. 26, pl. 2, figs, 3, 4.
1886. *Chrysodium lanzaeanum* (Vis.) : Gardner, p. 402, pl. 3, fig. 5.
1925. *Acrostichum* (*Chrysodium*) *lanzaeanum* (Vis.) : Chandler, p. 10.
1926. *Acrostichum lanzaeanum* (Vis.) : Reid & Chandler, p. 33, pl. 1, figs. 4, 5.
Acrostichum lanzaeanum (Vis.) : Chandler (in press), pl. 5, figs. 4, 5. Dorset Pipe-clay Series.

Reference to pinnules from Hordle was made by Chandler in 1925 and the first description, based on material in the Sedgwick Museum, Cambridge, was published by Reid & Chandler in 1926. In the British Museum there are seven further specimens (41420(5), V.42050–51) one of which shows no nervation so is doubtful and one showing the branching of the pinna. All are preserved in a carbonaceous grey clay and appear to come from Bed 10 below Hordle House.

Two fragments collected by H. Eliot Walton (V.42057–58) one of which showed also a seed of *Spirematospermum* (V.42057*a*) were alleged to come from the Barton Beds and a similar specimen, also collected by Walton, is in the Geological Survey Museum (7927). Mr. Walton was an amateur with no scientific training and the specimens may have been found loose on the foreshore. In view of the continuity of the Barton and Hordle sections the origin of this material requires confirmation by the finding of fresh pinnules at recognized Barton horizons. There is, however, no reason why the fern should not occur in the more estuarine Barton Beds for it persists from the Dorset Pipe-clay Series up to the Bembridge Series. A frond is shown (Pl. 24, fig. 2) for comparison with Hordle pinnules figured by Reid & Chandler, 1926 (see above).

Family Salviniaceae

Genus ***SALVINIA*** Adanson

Salvinia mildeana Goeppert

(Pl. 24, fig. 1)

1886. *Salvinia* sp. Gardner, p. 395.
1925. *Salvinia hantoniensis* Chandler, p. 10, pl. 1, fig. 1*a–d* ; text-fig. 1.
1956. *Salvinia mildeana* Goeppert : Shaparenko, p. 30, pl. 1, figs. 1–3 ; text-fig. 9. Where earlier references to *S. mildeana* are given in full.

In a detailed study of the genus *Salvinia*, both living and fossil, Shaparenko (1956) has shown that the Hordle species should be referred to *S. mildeana*, a widespread form in the Tertiary of Europe from the Eocene to the Upper Miocene as shown by the list of fossil occurrences which he gives on p. 30. Material from Bed 10 below Hordle House is well represented in the British Museum. V.20010 and V.36341–46 include the specimens figured by Chandler (1925) and two unfigured specimens. V.36343 (Chandler, 1925, pl. 1, fig. 1*c*) also shows the counterpart of V.36342 (Chandler, 1925, pl. 1, fig. 1*b*) while V.36341 (Chandler, 1925, pl. 1, fig. 1*d*) shows the counterpart of V.36344 (Chandler, 1925, pl. 1, fig. 1*a*). V.36346 includes fourteen specimens from a single ironstone block found *in situ* two feet above the mammal bed in the foreshore. There are also nine blocks (V.43698), and one specimen (V.43699) in grey clay matrix.

GYMNOSPERMAE

Family Podocarpaceae

Genus ***PODOCARPUS*** (L'Hérit.)

? Podocarpus sp.

1883. *Podocarpus* sp. Gardner, p. 49, pl. 2, figs. 13, 14.

In a discussion under the heading *Podocarpus eocenica* Unger Gardner refers to two small coriaceous leaves from Hordle (spelt Hordwell) which he figures (V.15117–18). Another incomplete detached leaf impression is in the British Museum

(V.15119). Gardner comments of these leaves " if referable to *Podocarpus* " [they] " would probably belong to another species " [i.e. not to *P. eocenica* from Bournemouth which he was describing]. As the material is so doubtful and ill-preserved it is ignored in the plant list. The preservation suggests " Bed 10 " below Hordle House.

Family TAXODINEAE

Genus ***SEQUOIA*** Endlicher

Sequoia couttsiae Heer

The Hordle material is discussed and illustrated in detail in a forthcoming monograph on the Flora of the Dorset Pipe-clay Series (Chandler, in press) in which *Sequoia couttsiae* from all known Tertiary sites in the South of England is investigated. Hordle material is registered under the numbers V.20011–18, V.42052–53. It is particularly common in Bed 10 between Hordle House and Long Mead End and just east of Beckton Bunny ; it also occurs in the contemporary channel west of Long Mead End and is rare (V.20017) in the *Chara* Bed east of Long Mead End (Beds 27–29 of Tawney & Keeping).

ANGIOSPERMAE

Class MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus ***POTAMOGETON*** Linnaeus

Potamogeton pygmaeus Chandler

(Pl. 24, figs. 3–6)

1925. *Potamogeton pygmaeus* Chandler, p. 13, pl. 1, fig. 3.
1926. *Potamogeton pygmaeus* Chandler : Reid & Chandler, p. 66, pl. 3, figs. 20–22.

The range has now been extended backwards into the Bournemouth Beds as will be described in a later monograph. Specimens have also been found in the *Limnocarpus* Band, Lower Headon, Colwell Bay, Isle of Wight (Pl. 24, figs. 3, 4). The holotype (V.20019) is in poor condition so a fruit impression (with counterpart V.17537) from the Bembridge Beds has been chosen as the neotype. It shows style and spines beautifully preserved (Reid & Chandler, 1926, pl. 3, fig. 20). There are about fourteen other specimens from Hordle which show spine bases, some having the valve preserved (V.20020–20*a*, V.42056). They are from Bed 10 east of Beckton Bunny. P. I. Dorofeev considers (*ex lit*) that the nearest living affinity is with the North American *Potamogeton spirillus* Tuckerm.

Genus ***LIMNOCARPUS*** Reid emend. Reid & Chandler, 1926 : 68

Limnocarpus forbesi (Heer)

(Pl. 24, figs. 7–11)

For synonyms and references see Chandler, 1961*a*, p. 28.

The species formerly designated *L. headonensis* (Gardner) must now be referred to *L. forbesi* (Heer) for reasons explained by Chandler (1961*a* : 28). Endocarps are extremely abundant at certain horizons in the Lower Headon Beds at Hordle, notably in the Crocodile Beds between Hordle House and Long Mead End (Bed 15 of Tawney & Keeping) and in the *Limnocarpus* Band formerly peculiarly well displayed at Paddy's Gap, Milford-on-Sea. Figured specimens still extant are V.20021 (Chandler, 1925, pl. 1, fig. 4*a*) and V.20022*b* (Chandler, 1925, pl. 1, fig. 4*b*). The originals of Chandler, 1925, pl. 1, fig. 4*c* and text-fig. 3 have decayed but V.20023 still shows five endocarps split longitudinally through the funicle and placenta as in the text-figure. Other specimens from Hordle are V.20022*a*, *c*, V.20024–27 (including four paired endocarps), V.20028–30, V.31789, V.42059–60.

Endocarps (V.42062–63) were also found in a bomb crater at 50 ft. O.D. on the east side of the Dane stream, Downton, Hordle. The crater showed about 5 ft. of white micaceous sand like the *Unio* sands of Paddy's Gap, Hordle cliff, and below were 10 ft. of greenish clay with a band of *Limnocarpus* 6 ft. down.

At Colwell Bay, Isle of Wight, Groves collected numerous specimens (V.42064–67) in the *Limnocarpus* Band (exact site unspecified) and Chandler obtained others (V.42068) at the same horizon below Warden Battery.

Family Hydrocharitaceae

Genus ***STRATIOTES*** Linnaeus

Stratiotes headonensis Chandler

(Pl. 24, fig. 17)

1923. *Stratiotes headonensis* Chandler, p. 117, pl. 5, figs. 1–3, 24–26 ; pl. 6, fig. 23.
1925. *Stratiotes headonensis* Chandler : Chandler, p. 14.
1960. *Stratiotes headonensis* Chandler : Chandler, p. 223, pl. 33, figs. 96, 97.

A full description of the species was given in 1923. For convenience of comparison with *S. hantonensis* a diagnosis is given : Seed oblong, ovate or subtrigonal, somewhat flattened, hooked at the base. Keel often from one-third to one-half the breadth of the seed. Collar small, conspicuous, usually warty. Testa thick, woody with marked longitudinal ridges. Micropyle basal or subbasal, usually oblique. Hilum basilateral, raphe marginal or submarginal almost to the apex. Cells of internal surface of keel much contorted. Length of seed from about 3·25 to 6·5 mm. ; breadth about 2·25 to 4 mm.

Remarks. The following were figured by Chandler, 1923, pl. 5, fig. 1 (V.40068), pl. 5, fig. 2 (V.40067*a*), pl. 5, fig. 24 (V. 40066). The species is very abundant in

Bed 10, 49438, V.13567, V.16538, V.20031–32, V.31788, V.40067–68*a*, V.42073, V.42078 (precise position in the cliff unspecified), V.42069 (east of Beckton Bunny), V.42070 (below Hordle House). Also very abundant in Bed 31 at Paddy's Gap (V.42066, V.42071). It occurs sparsely in Bed 29 between Hordle House and Milford Corner (V.42072). Horizon in Lower Headon Hordle unspecified in V.16537–38*a*.

It is equally abundant at Colwell Bay, V.42076 (Chandler, 1923, pl. 5, fig. 3), V.42077, V.42079–81, all presumed Lower Headon, and V.42074 *Limnocarpus* Band, site unspecified, V.42075 same band below Warden Battery.

The oldest record of the species up to date is at Horizon L. of the Barton Series, Barton cliff (Chandler, 1960 : 223).

Stratiotes hantonensis Chandler

(Pl. 24, figs. 12–16)

1960. *Stratiotes hantonensis* Chandler, pp. 205, 222, pl. 30, figs. 18–25 ; pl. 33, figs. 87–95.

The description given in 1960 applies equally to the seeds from the Lower Headon Beds. Typical measurements of Hordle material are 2·6 by 1·6 mm. ; 2·8 by 1·2 mm. ; 3 by 1·6 mm. ; 3 by 1·5 mm. The thickness of the seeds is about 1·3 mm. This small species was overlooked when *S. headonensis* was described in 1923, its tiny seeds being merely regarded as small immature examples of *S. headonensis*, only about sixteen specimens (V.42082–86*a*) were found. Now that *S. hantonensis* has been collected in large numbers in older beds ranging from Bournemouth through the Hengistbury Beds, Highcliff Sands and Barton Beds its distinctive characters are well known and it was no longer confused with *S. headonensis* when the Hordle seeds were re-examined. The range of the two species therefore overlaps at the western end of the Hordle section. So far only gatherings of *S. headonensis* from Bed 10 close to Beckton Bunny have yielded *S. hantonensis*. The absence from older deposits of typical *S. headonensis* with its broad flat keel, coarse pitting, pronounced ridges and larger size in association with *S. hantonensis* confirms that the latter is a distinct species.

Family Cyperaceae

Genus *CARICOIDEA* Chandler, 1957 : 86

Caricoidea minima (Chandler)

(Pl. 24, figs. 18–21)

1925. *Cladium minimum* Chandler, p. 14, pl. 1, fig. 5*a*, *b*.
Caricoidea minima (Chandler) Chandler (in press), pl. 7, fig. 1.

Diagnosis. Fruit sub-obovoid sometimes slightly flattened laterally, rather abruptly narrowed to the apex, truncate at the base. Fruit wall thick, epidermis of digitate rectangular cells. Length about 2·75 to 3 mm. ; maximum diameter, 2 to 2·5 mm. Endocarp oburceolate with short truncate basal neck, rounded or

pointed apex. Wall of two layers the inner columnar in section, formed inside and out of conspicuous equiaxial cells. Length, 1·25 to 1·65 mm.; breadth, 1 to 1·55 mm. Seed with testa of transversely elongate cells.

Holotype. Brit. Mus. (N.H.), No. V.20033.

Description. *Fruit:* Sub-obovoid, sometimes slightly flattened laterally, truncate at the base which has a short canal with large foramen marking the attachment. Somewhat pointed at the apex, not conspicuously attenuated or mucronate but abruptly narrowed. Epidermis shining of digitate cells usually more or less rectangular and somewhat longitudinally elongate and aligned, their width about 0·012 to 0·016 mm. Wall thick, spongy, formed of a mass of equiaxial cells about 0·01 mm. in diameter. Length of fruit, 2·75 to 3 mm.; maximum diameter, 2 to 2·5 mm.

Endocarp: More or less oburceolate but contracted rather abruptly as a rule to form a short truncate basal neck pierced by a canal, rounded or pointed at the apex, sometimes with two or three external strands of longitudinal fibres. Wall thick, compact tending in fossilization to separate into two layers, an outer compact close-textured layer about 0·15 mm. thick and an inner layer, columnar in section, about 0·037 mm. thick formed superficially inside and out of equiaxial cells about 0·016 mm. in diameter. Length of endocarp about 1·25 to 1·65 mm.; breadth, 1 to 1·55 mm.

Seed: Represented by testa formed of transversely elongate cells arranged in rows.

Remarks. Detached endocarps (V. 20033, V.20033*a*) were described as *Cladium minimum* before fruits had been seen (Chandler, 1925 : 14, pl. 1, fig. 5*a*, *b*). Fruits from Bed 10 (V.42087–88, V.42091) and additional endocarps (V.42089–90) have now been found. Four crushed endocarps have also been recognized from Bed 29 in the lignitic bands (V.20047*b*). While relationship is certainly with the Caricoideae the fruit characters show that these specimens differ from *Cladium* itself which has a thin spongy fruit wall and an epidermis of large rectangular smooth-walled cells. The fossils are therefore referred to the form-genus *Caricoidea* pending the discovery of further evidence. A fruit has now been found in the Dorset Pipe-clay Series at Arne.

Caricoidea obscura Chandler

(Pl. 24, figs. 22–24)

1960. *Caricoidea obscura* Chandler, pp. 207, 223, pl. 30, figs. 27–33; pl. 33, figs. 98–105.
Caricoidea obscura Chandler : Chandler (in press), pl. 6, figs. 20–33.
1961*a*. *Caricoidea obscura* Chandler : Chandler, p. 33, pl. 7, fig. 34.

Description. *Fruit:* As described from Hengistbury (p. 207 quoted above). The single fruit seen from Hordle has a somewhat three-sided basal truncation and is itself obscurely three-sided one side being broader and flatter than the other two. Epicarp although poorly preserved shows the finely digitate cell walls about 0·016 mm. broad. Beneath the epicarp the equiaxial cells of the spongy tissue are about 0·01 mm. in diameter and light brown in colour. Length about 1·75 mm.; breadth, 1·5 mm.

Endocarp : Also as described. One or more longitudinal ridges arise at the base and gradually die out on the body of the endocarp but these are not always present. Surface smooth externally and the spongy wall, about 0·07 mm. thick, is formed of equiaxial cells. Dimensions of several endocarps are : 1 by 0·8 mm. ; 0·9 by 0·75 mm. ; 1·15 by 0·85 mm. ; 1 by 0·7 mm. ; 0·9 by 0·9 mm.

Seed : Poorly preserved represented only by much decayed adherent testa formed of transversely elongate cells which produce striae about 0·012 mm. apart.

Remarks. About a dozen endocarps were found (V.42095) in addition to the figured material. The species is based on well preserved fruits and endocarps from the Highcliff Sands near Mudeford and the Dorset Pipe-clay Series and also awaits description from the Bournemouth Freshwater Beds. Specimens have been described from the Upper Hengistbury and Lower Barton Beds (Chandler, 1960).

Genus *SCLERIA* Berg.

Scleria hordwellensis n. sp.

(Pl. 24, figs. 25, 26)

Diagnosis. Fruit subglobular, mucronate at the apex, flattened at the base and seated on a rounded triangular thick disc with transversely puckered surface. Surface of fruit smooth but with slight longitudinal fluting on the sides. Surface of both fruit and disc of equiaxial cells. Length of fruit with mucro and disc, 1·75 mm. ; breadth, 1·75 mm.

Holotype. Brit. Mus. (N.H.), No. V.42096.

Description. *Fruit :* Subglobular with short thick apical mucro. Base somewhat flattened pierced by an aperture but without a narrow neck like that of *Cladium* and *Mapania*. Circumference of fruit rounded not triangular. Sides slightly grooved or fluted longitudinally, seated when found on a thick rounded triangular disc which still adheres on one side but is elsewhere now broken. Its removal has shown a rounded triangular scar at the base of the fruit itself about 1·3 mm. in diameter. The angles of the disc originally extended half way up the fruit. Its surface is rippled or puckered transversely. Epidermis of fruit and disc formed of equiaxial cells, many about 0·008 mm. in diameter. Inside the disc as shown along the broken edge are equiaxial cells, 0·016 mm. in diameter. Length of fruit with disc and mucro, 1·75 mm. ; breadth, 1·75 mm.

Remarks and affinities. One fruit which suggests relationship to *Scleria* of the type *S. laevis*. The genus occurs in all tropical and subtropical regions with a single species in Atlantic North America.

Family Cyperaceae, Genus ?

(Pl. 24, fig. 27)

A fruit (V.42097) too poorly preserved for generic determination. Suboval in outline, shortly stipitate with acuminate apical style. Probably originally inflated but somewhat compressed in fossilization. Surface with regular equiaxial cells about 0·025 mm. in diameter with raised walls (these possibly due to differential decay). Length of fruit, 1·45 mm. ; breadth, 1 mm.

Family Zingiberaceae

Genus ***SPIREMATOSPERMUM*** Chandler, 1925 : 17

Spirematospermum headonense n. sp.

(Pl. 24, figs. 28–30 ; Pl. 25, figs. 31, 32)

1925. *Spirematospermum wetzleri* (Heer) : Chandler, p. 17, pl. 1, fig. 8*a–c* ; text-fig. 5.

Diagnosis. *Fruit :* Bisymmetric with rounded upper surface and sharply angled lower margin hence obovoid in transverse section. Estimated length probably less than 25 mm.; maximum transverse diameter, 7 to 9 mm. Thickness of fruit wall, 0·228 mm. (maximum). Number of seeds in fruit probably not more than twelve arranged in one or two rows on parietal placentas in the plane of symmetry. Locules one ? or two ? Length of seeds, 6·25 to 7·25 mm. ; maximum breadth, 1·5 to 2·25 mm. All tissues of seeds spirally arranged in relation to the seed cavity.

Holotype. Brit. Mus. (N.H.), No. V.42098.

Description. *Fruit :* Inferior, bisymmetric, many-seeded, the maximum number of seeds estimated to be not more than twelve, eight actually counted in the holotype. Truncate lanceolate, the apex bearing a flat elliptical superior perianth disc (V.42100 Chandler, 1925, text-fig. 5 (4)). Base narrowing gradually into a thin curved stalk (V. 42098–99). Upper margin rounded, lower sharply angled in the plane of symmetry the angle being continued along the stalk, so that clearly it is an original feature ; hence in transverse section the fruit is obovoid. External surface ornamented with longitudinal ribs due to fibres within the wall. Whole surface covered by square or hexagonal cells from 0·027 to 0·055 mm. broad, arranged more or less regularly in longitudinal rows. Cell walls thin, possibly the cells were much inflated in life and have collapsed. Thickness of fruit wall now 0·055 to 0·228 mm. at most. Even supposing that the wall has been thinned by collapse of the cells on drying the maximum original thickness can scarcely have exceeded 0·35 mm. (contrast *S. wetzleri* (Heer) from the German Brown Coal 3 to 6 mm. thick). Number of locules cannot be verified in the absence of new and better material, although it should be borne in mind that the supposed septum may have been inner layers of fruit wall separated by maceration. Seeds arranged in one or two rows on parietal placentas in the plane of symmetry. (*S. wetzleri* one-loculed with three parietal placentas and six rows of seeds.) Although no fruits are complete it is estimated that not more than a dozen seeds can have been enclosed by these small fruits. Eight are preserved in the holotype (numerous seeds in excess of twelve are shown in the figures of *S. wetzleri*). Dehiscence by irregular fracture or dissolution of the fruit wall. Estimated length of fruit not less than 20 or more than 25 mm. Maximum diameter, 7 to 9 mm. (*S. wetzleri* 25 to 100 mm. in length. Maximum diameter, 30 mm.)

Seed : (V.20037–38*a*, V.42101) Anatropous ; varying in shape through mutual pressure in the pod, hence frequently somewhat facetted, elongate, often sub-cylindrical, apex rounded or pointed, base truncate directed towards the apex of the fruit. Base with a funnel-shaped depression which encloses the hilum, a lateral opening leading into the lateral raphe canal which traverses the thick testa to the

subapical chalaza (Chandler, 1925, text-fig. 5 (1)). At the base of the depression is the circular micropylar opening into the seed cavity. In well preserved specimens it is closed by a thin circular plug with central external mucro. The raphe opens into a small apical cavity at the extremity of the flask-shaped seed cavity and the chalaza is situated where the two cavities are adjacent.

The testa is thick and in all layers the cells are arranged spirally around the seed cavity, an arrangement apparent in weathered or dissected specimens but not seen in a freshly sectioned surface or thin section. The epidermis is smooth and shining externally with spiral striae, deeper striae alternating with four or five slighter ones. The cells which form this surface are very long and narrow as described by Kirchheimer for *S. wetzleri* but in sections of the seed they produce a coarsely columnar effect. Within the epidermis in longitudinal sections of the seed two closely fused thick layers are distinguishable. The outer of these, about 0·11 mm. thick in one seed measured, shows small equiaxial cells (secreting ? or endosperm cells ?). They represent the transverse diameters of spirally arranged cells (in *S. wetzleri* this outer layer has tangentially elongate cells as seen in section). The inner layer is 0·275 to 0·33 mm. thick and the cells, in section equiaxial, are larger than those of the outer layer. A thin cuticle lines the seed cavity which is formed of hexagonal cells, 0·018 mm. in diameter. The spiral arrangement of the inner layers is clearly seen impressed on the lining of the seed cavity. Length of seeds, 6·25 to 7·25 mm.; diameter, 1·5 to 2·25 mm. (*S. wetzleri* length, 5 to 10·2 mm.; diameter up to 5 mm.).

Remarks. Fruits and seeds were formerly obtainable in Bed 10 below Hordle House and it appears fairly certain that the holotype was from this site where Mr. & Mrs. Clement Reid were in the habit of collecting. Seeds were rare in Beds 27–29 (V.20038). A seed embedded in a mass of *Acrostichum* (V.42057*a*) was alleged to be from Barton but see comment on p. 102.

In 1936 and again in 1957 the structure of *Spirematospermum wetzleri* (Heer) from the German Brown Coal was fully described by Kirchheimer. Much help in interpreting details of structure in the Headon material was obtained from his work. The existing condition of Hordle cliff makes it impossible to find new material for further study and this is unfortunate as only three fruits (all imperfect) and a number of isolated seeds are known. All the fruits show consistent characters which now seem to distinguish them from the typical Brown Coal *S. wetzleri*. These distinctive characters are indicated in the above description by introducing the corresponding features of *S. wetzleri* in brackets. There seems to be no doubt that the bisymmetry of the Hordle fossils is original and the fruits were never round in transverse section. The almost papery thin walls are unlikely through shrinkage on drying to have been derived from walls 3 to 6 mm. thick like those of *S. wetzleri*. The number of locules cannot finally be settled at present. However apart from this doubtful character the shape, size and thickness of the German fruits, the larger number of seeds, and the size of these seeds seem sufficient ground for separating the specimens from Hordle as a distinct species, *S. headonense*.

Kirchheimer is in agreement that the genus *Spirematospermum* is an extinct member of the family Zingiberaceae.

The figures and description of *Spirematospermum* from the Bovey Tracey Lignite, Devon, give insufficient evidence as to the species which has therefore been retained in *S. wetzleri* as originally described. The small size of the isolated seeds from Bembridge suggests that these should possibly be redesignated *S. headonense* although they fall within the range of size of the Oligocene *S. wetzleri*.

Class DICOTYLEDONES

Family Myricaceae

Genus *MYRICA* Linnaeus

Myrica boveyana (Heer) pars

(Pl. 25, figs. 33, 34)

1862. *Carpolithes boveyanes* Heer, p. 1077, pl. 70, ? figs. 7–14 (in part).
1957. *Myrica boveyana* (Heer) pars : Chandler, p. 90, pl. 12, figs. 45–48.
1961. *Myrica boveyana* (Heer) pars : Chandler, p. 328, pl. 33, figs. 1–4.

Description. *Endocarp :* One-loculed, bisymmetric, splitting into equal valves. Valves more or less oval in outline, somewhat inflated. External surface so much abraded as to show little structure but a few obscure rather irregular longitudinal furrows for fibres. Locule suburceolate, not nearly as deep as broad, narrowing above into the apical stylar canal. Wall pierced at the base by a short straight canal for the funicle. Marginal sutures wide, smooth, flat, close-textured, broadest at about a quarter of the length from the apex where they may be 0·6 to 0·7 mm. wide. These wide sutures tend to produce a slight marginal flange on the outer surface which appears to break readily owing to its thinness as shown in one specimen. At the base of the endocarp the suture is narrower and only about 0·2 mm. wide. Seed not preserved. Length of endocarp, 2·75 mm. ; maximum breadth, 2·5 mm.

Remarks. Two valves from different endocarps. Although so abraded and sand-pitted that the cell structure is obscure, they appear to be indistinguishable from *M. boveyana* (Heer) from the Oligocene Lake Basin of Bovey Tracey, Devon, and from the London Clay of Nursling, Southampton, judging by size, proportions and locule shape.

Family Betulaceae

Genus *CARPINUS* Linnaeus

Carpinus boveyanus (Heer)

(Pl. 25, fig. 35)

1862. *Carpolithes boveyanus* Heer, p. 1077, pl. 70, figs. 7–14 (in part).
1957. *Carpinus boveyanus* (Heer) pars : Chandler, p. 92, pl. 13, figs. 52–67.

Description. *Fruit :* Pointed-ovate in outline, bisymmetric, much compressed with large basal scar of attachment of which half is on each face. Surface covered

by an accrescent calyx. Longitudinal furrows arise at the margin of the scar; three can be seen on one face, four on the other but owing to abrasion they become obscure in places, some being entirely obliterated. The vascular strands they once contained are not preserved. External surface finely striae, the striae formed by elongate cells about 0·009 to 0·012 mm. broad. Beneath this surface and partly exposed by abrasion are equiaxial cells about 0·025 mm. in diameter. Length of fruit, 2·8 mm.; breadth, 2·25 mm.; thickness, 0·75 mm. Diameter of basal scar, 1 mm.; height measured on one surface, 0·25 mm.

Remarks and affinities. One fruit with accrescent calyx preserved but no bract. Comparison with fruits from the Bournemouth Marine Beds at Southbourne, the Highcliff Sands (both awaiting publication) and the Bovey Tracey Beds, Devon, indicate that a single species occurs at all these localities.

Family Moraceae

Genus *BROUSSONETIA* L'Hérit.

Broussonetia rugosa Chandler

(Pl. 25, figs. 36, 37)

1925. *Broussonetia rugosa* Chandler, p. 21, pl. 3, fig. 1*a*, *b*.

Diagnosis. Endocarp suboval in outline with knob-like projection carrying stylar canal and funicular opening, bisymmetric, somewhat compressed at right angles to plane of symmetry. Surface finely pitted, ornamented with elongate tubercles with sinuous outlines. Thick inner part of wall columnar. Dimensions: 1·75 by 1·4 mm.; 1·25 by 1 mm.

Description. *Endocarp:* Suboval in outline, with knoblike projection at one end, bisymmetric, somewhat compressed at right angles to the plane of symmetry with broad surfaces gently convex. Stylar canal and funicular canal adjacent on the projection. Endocarp splitting marginally for germination, having a single pendulous seed. External surface ornamented with elongate tubercles having irregular sometimes sinuous outlines. The tubercles radiate from the stylar projection. Whole surface finely pitted. Thickness of wall about 0·1 mm., seen in section to be formed of an outer thin compact layer and an inner thick layer of columnar cells. Diameters of two endocarps in plane of symmetry: 1·75 by 1·4 mm. and 1·25 by 1 mm.

Remarks. In addition to the two figured specimens there are three fragments (V.20039*a*). The projection at one end of the endocarp is seen in living material of *Broussonetia* and *Morus* to taper into the funicle but in the fossils the funicle itself is gone and only the worn down process remains. The fossils resemble *Ficus* in size and form but no rugose species of *Ficus* has been seen whereas in *Broussonetia* all the characters described are present.

Section MOROIDEAE

Genus *MOROIDEA* Chandler, 1957 : 95

Moroidea hordwellensis n. sp.

(Pl. 25, fig. 38 ; Text-fig. 1)

Diagnosis. Fruit more symmetric than *M. boveyana*, with broad flat stylar projection and canal. Dimensions in plane of symmetry : 1·7 by 1·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.42105.

Description. *Fruit :* Bisymmetric, subcircular in outline, cuneate in transverse section, the narrow edge crested for nearly half the circumference and the opposite edge rounded. Style and funicle close together each marked by a conspicuous marginal prominence. The stylar prominence is broad, flattened terminal on the crested margin and pierced by a flat canal 0·1 mm. broad ; the attachment or funicular prominence is recurved away from that of the style, subapical, terminal on the rounded margin. Pericarp 0·1 mm. thick along the crest, 0·05 mm. thick on the rounded margin, hard, woody formed of compact parenchyma, the cells on the external surface measuring about 0·012 to 0·016 mm. in diameter and in sections of the wall showing a radial alignment. Locule lining of approximately hexagonal cells about 0·025 mm. broad and 0·05 mm. long, their longer axes diverging from the placental region giving rise to obscure divergent striae. Dehiscence occurs along the crested margin. Seed solitary, pendulous from the subapical placenta which immediately underlies the funicular prominence, the funicle being short and thick. Dimensions of fruit in plane of symmetry, 1·7 by 1·5 mm. ; thickness at right angles to plane of symmetry, 1 mm. Length of funicular prominence, 0·17 mm.

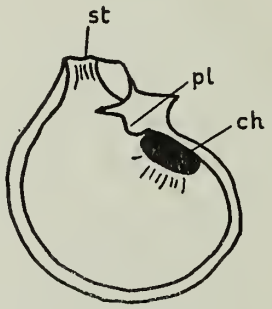

Fig. 1. *Moroidea hordwellensis* n. sp. Longitudinal section through fruit and seed. (*st*) stylar prominence, (*pl*) placenta, (*ch*) chalaza on closely adherent seed within fruit. ×21 approx.

Seed : Campylotropous, chalaza conspicuous, subcircular, 1·2 mm. in maximum diameter contiguous with the hilum but on the far side of it from the style as the

seed is seen lying within the fruit. Testa brittle, only 0·025 mm. thick tending to adhere to the locule, formed of small equiaxial cells 0·012 to 0·016 mm. in diameter near the hilum where best preserved. Inner surface of testa with elongate cells about 0·025 mm. broad, having cell walls represented by a double line.

Remarks and affinities. One fruit slightly broken near the crested margin and, on one surface, near the attachment. The broken surface was subsequently removed and the remains of a seed exposed. Only the hilar end of the seed was preserved but it showed the perfect chalaza scar.

Form and structure indicate Moraceae and probably the section Moroideae (Engler) or the Artocarpoideae in both of which the seeds may be campylotropous and the chalaza in the position described. On the whole the Moroideae appear to bear the closer resemblance to the fossil. A species distinguished by a narrower stylar prominence and canal and greater asymmetry was described from Bovey Tracey under the name *Moroidea boveyana* Chandler (1957 : 95, pl. 13, fig. 74).

Genus ***BECKTONIA*** nov.

Diagnosis. One-loculed one-seeded endocarps referable to Moraceae, roundly triangular at apex the angles alternating with more or less flattened sides, rounded below, with oblique apical foramen and placenta subjacent to it. Length, 3·3 to 4·25 mm. ; breadth, 2·4 to 3·5 mm. (compressed).

Type Species. *Becktonia hantonensis* n. sp.

Becktonia hantonensis n. sp.

(Pl. 25, fig. 39)

Diagnosis. That of the genus.

Holotype. Brit. Mus. (N.H.), No. V.42106.

Description. *Endocarp :* Subovoid, roundly triangular above, rounded below, the rounded apical angles dying out gradually but subsidiary intermediate ridges occurring in the lower part. Foramen for funicle subapical oblique. Surface rather rough formed of fine equiaxial cells 0·007 to 0·008 mm. in diameter. Wall about 0·15 mm. thick, close textured in section, carbonized so that cell structure is obscure but a radial or columnar alignment can be detected. Length, 4·25 mm. ; breadth (reduced by contraction), 2 mm.

Remarks and affinities. An endocarp bursting below. The specimen is identical with endocarps from the Bournemouth Freshwater Beds awaiting publication. These endocarps range in length from 3·3 to 3·5 mm. ; breadth, 2·4 to 2·75 mm.

The single seeded locule with hard endocarp, locule lining with digitate cells (seen in the Bournemouth specimens), oblique funicular aperture and pendulous anatropous seed (also seen in Bournemouth specimens) indicate the family Moraceae.

Order CENTROSPERMAE

Family CARYOPHYLLACEAE

Genus ***HANTSIA*** Chandler, 1960 : 209

Hantsia pulchra (Chandler)

(Pl. 25, fig. 40 ; Text-fig. 2)

1925. *Corydalis pulchra* Chandler, p. 25, pl. 3, fig. 10*a*, *b*.
1929. *Corydalis pulchra* Chandler : Reid & Chandler, pl. 1, fig. 18.
1960. *Hantsia pulchra* (Chandler) Chandler, p. 209, pl. 31, fig. 39.

DESCRIPTION. *Seed :* Obliquely or transversely oboval or subcircular in outline, much compressed laterally, bisymmetric about a plane passing through hilum and micropyle. Seed cavity undivided by any partition between the limbs of the large

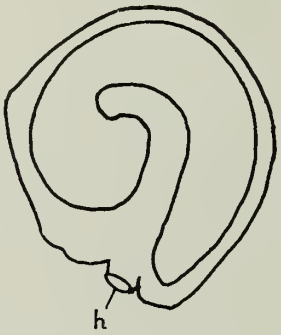

FIG. 2. *Hantsia pulchra* (Chandler). Longitudinal section through a seed showing large embryo (inferred) and large hilar opening (*h*) between limbs. ×15.

curved embryo of which the radicular limb is longer and narrower than the other. The embryo may have occupied the whole seed cavity or have been surrounded by only a thin film of endosperm as is suggested by the surface contours (cf. Pl. 25, fig. 40). Hilum a large oval or subcircular gaping aperture between the tips of the limbs with smooth raised rim and cells with straight walls. Testa formed of two coats, the outer 0·1 to 0·15 mm. thick, black and shining, closely and conspicuously tubercled, the tubercles being dome-shaped and subcircular in outline except around the margin and over the micropylar limb where they tend to be elongate parallel with the margin. Each tubercle arises from a single " cell " or area with finely toothed outline, the teeth measuring about 0·02 mm. in breadth, the diameter of the tubercled areas being about 0·07 to 0·1 mm. The teeth are frequently but not invariably difficult to see in surface view but are clear on broken edges where they produce a columnar effect on account of the rounded ridges they form on the sides of the cells. The testa readily cracks along these toothed outlines. The tubercled areas sometimes break down and then appear to be formed of small equiaxial cells 0·016 to 0·025 mm. in diameter. An inner black coat, 0·016 mm. thick where measured, may become partly separated in fossilization from the outer

coat. Its surface is close textured formed of equiaxial cells about 0·015 mm. in diameter. Tegmen light brown, semitranslucent, of straight-sided angular cells about 0·012 to 0·015 mm. in diameter, rough. Dimensions of typical seeds are : 1) Length along axis between limbs, 2 mm. ; breadth across both limbs, 2·5 mm. 2) Length, 2·25 mm. ; breadth, 1·75 mm.

Remarks. The species was originally referred to the genus *Corydalis* but fuller information now available suggests that the affinities need revision. Fine teeth around the tubercled surface cells (or areas) were originally overlooked but have now been clearly seen. No such digitate cells occur in *Corydalis* where the walls of the tubercled areas are straight and smooth. Again in *Corydalis* the tegmen is thin and diaphanous adhering closely to the outer coat and is formed of large irregular cells which vary in size from 0·016 by 0·05 mm. to 0·012 by 0·08 mm. This in no way resembles the tegmen of the fossil with its small uniform equiaxial cells. Further search was therefore made in the order Centrospermae which has large curved embryos occupying the circumference of the seed. Among the Chenopodiaceae *Beta* shows superficially similar cells but these are smooth walled not digitate ; its tegmen is similar to that of the fossil. Portulacaceae, with digitate cells, is excluded by the form of the seed. In Caryophyllaceae the tubercles are always finely digitate while in *Saponaria* they may be similar in appearance and distribution. Again the limbs of the curved seed may be unequal as in the fossil but there is no conspicuous hilar rim projecting between them although the tegmen is formed of small equiaxial cells. In *Silene* a hilar rim occurs but shows distinct digitate cells on its surface and the testa cells are radially aligned the limbs of the seed being more or less symmetrical. No living genus seen shows all the characters described but as they do occur within the family Caryophyllaceae the nearest relationship is presumed to lie here. The generic name indicates the geographical origin of all specimens to date. In addition to the figured material there are a number of broken or incomplete seeds (V.42108–09) some of which show important characters.

Hantsia glabra n. sp.

(Pl. 25, figs. 41–43)

Diagnosis. Resembling *H. pulchra* except in the smooth surface, the digitate cells being flat or scarcely convex, not markedly tubercled. Dimensions of best developed seed : 2·3 by 2 mm.

Holotype. Brit. Mus. (N.H.), No. V.42111.

Description. *Seed :* Subcircular or transversely oboval in outline, much compressed laterally, bisymmetric about a plane passing through hilum and micropyle, embryo curved with unequal limbs the micropylar limb longer and narrower than the other. Seed cavity not divided by a partition between the limbs. Hilum a large oval or subcircular gaping aperture between the limbs or almost terminal on the narrower limb surrounded by smooth upstanding rim as in *Hantsia pulchra*. Testa black and shining formed of cells which are subcircular or oval in outline with finely toothed margins having from about nine to fifteen small teeth. The

surface of these cells is flat or very slightly convex not tubercled as in *H. pulchra*. The testa has a marked tendency to break along the toothed outline of the cells. Surface of cells finely granular. Size of cells varying from about 0·075 to 0·1 mm. in diameter but on the tip of the micropylar limb they are much smaller and some at least are straight-sided not toothed. Along the circumference of the seed they tend to be elongate and narrower. These toothed cells show clearly on the inner surface of the testa which is about 0·05 mm. thick. There are traces of a thin light brown inner coat (tegmen?) not clearly seen. The manner in which the cells of the outer coat break up suggests that they may be formed of groups of smaller equiaxial cells which perhaps give rise to the granular appearance. Greatest diameter of seed measured across two limbs, 2·3 mm.; greatest diameter at right angles to this in plane of symmetry, 2 mm.; thickness at right angles to plane of symmetry, 0·4 mm. Hilar aperture including thickness of wall, 0·1 by 0·15 mm. A second seed is distorted so does not give correct measurements but may have been somewhat smaller.

Remarks. Obviously related to *Hantsia pulchra* which it closely resembles in everything but its smooth surface and in the apparent absence of an inner coat of the testa formed of small equiaxial cells. The possibility that both may belong to a single species with some smooth and some tubercled seeds as in Caryophyllaceae and Fumariaceae cannot be excluded, but the difference in the fossils is so pronounced that pending further discovery as to closer relationship it appears best to regard them as distinct.

In this as in *H. pulchra* a depressed area between the limbs on the broad surfaces suggests a large embryo, probably with little albumen, having a conspicuous large radicle and broad cotyledonary limb.

Family Nymphaeaceae

Genus ***BRASENIA*** Schreber

Brasenia ovula (Brongniart)

1926. *Brasenia ovula* (Brongn.): Reid & Chandler, p. 99, pl. 6, figs. 15–18 (see for earlier references).
1957. *Brasenia ovula* (Brongn.): Chandler, p. 96, pl. 13, fig. 75.
1960. *Brasenia ovula* (Brongn.): Chandler, pp. 210, 224, pl. 31, figs. 40, 41; pl. 33, figs. 106, 107.

Seeds abound in the Lower Headon both at Hordle and Colwell Bay, certain horizons being blackened by their shining testas. At Hordle they are especially abundant in Beds 9 and 10 below Hordle House (V.20045–46, V.20048, V.42112–14 embryotegas) and just east of Beckton Bunny (V.42115), Bed. 29 (V.20047) and Bed 31 (V.20044). Site in Bed 10 unspecified (V.31790). At Colwell Bay a number of seeds collected by Clement Reid are presumed to come from the Lower Headon (V.42116–18). Those by J. Groves (V.42119) are from the *Limnocarpus* Band and those by Chandler (V.42120) from this same horizon below Warden Battery.

Brasenia spinosa Chandler

1925. *Brasenia spinosa* Chandler, p. 22, pl. 3, fig. 4 ; text-fig. 7.
1925. *Brasenia antiqua* Chandler, p. 22, pl. 3, fig. 5*a*, *b*.

Diagnosis. Seed globular or ovoid, raphe ridge inconspicuous. Surface with faint longitudinal ridges and slender spiney tubercles or broad, short or wart-like tubercles especially abundant over the chalazal end of the seed. Surface of interlocking digitate cells. Embryotega circular or elliptical with central rimmed micropyle and oblong or square convex surface cells with finely toothed margins. Tegmen semitranslucent of equiaxial angular frequently hexagonal thin-walled cells. Length of seed, 1 to 2·6 mm. ; breadth, 0·8 to 2 mm., exceptionally 2·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.20041*a* originally regarded as a distinct species named *Brasenia antiqua*. The original and only seed of *B. spinosa* now decayed.

Description. *Seed :* Globular or ovoid, anatropous, with inconspicuous longitudinal raphe ridge, hilum obscure where the ridge terminates against the embryotega. Surface with faint rounded longitudinal ridges, sometimes ornamented with slender spines or tubercles, sometimes with shorter, thicker, blunt or wart-like tubercles. The tubercles are usually most abundant over the chalazal end of the seed. The rounded ridges frequently correspond with the rows of cells which form the testa. The cells which may be about 0·05 to 0·1 mm. in diameter are digitate some having as many as ten digitations, others only six to eight ; these may be arranged in three or four pairs. Each tubercle or spine arises from the centre of a cell although not all cells bear tubercles. In section the testa may be about 0·125 to 0·15 mm. thick and shows radial columns with fluted walls, the flutings corresponding with the surface digitations. The testa tends to break along the outlines of these cells. Embryotega with a large rimmed median micropyle. Its cells are square or oblong, much inflated with finely toothed margins. Some of the embryotega cells are as much as 0·05 mm. in diameter. The tegmen is semitranslucent, formed of angular frequently hexagonal thin-walled cells about 0·075 mm. in diameter. The seeds vary greatly in size. Typical measurements are : 1) Length, 1·25 mm. ; breadth, 1·25 mm. 2) Length, 1·25 mm. ; breadth too crushed to measure. 3) Length, 1·5 mm. ; breadth, 1·25 mm. 4) Length, 1 mm. ; breadth, 0·8 mm. 5) Length, 1·2 mm. ; breadth, 1 mm. 6) Length, 2·6 mm. ; breadth, 2·5 mm.

Specimens from the Upper Headon of Colwell Bay range in size from : length, 1·25 to 2·5 mm. ; breadth, 1 to 2 mm.

Remarks. After examining a large number of specimens from the Upper Headon of Colwell Bay, it appears that *Brasenia antiqua* must be regarded as identical with *B. spinosa*, the two types with spiney tubercles and short thick tubercles respectively appear to grade into one another so that they cannot be separated. The variety with thick tubercles was fairly abundant at Hordle, the thin spined variety was scarce. Its small size as well as the large tubercles appear to distinguish this species from the living *B. schreberi* and from all other fossil forms

so far seen. *B. spinosa* is known from Bed 10 below Hordle House (V.20041, Chandler, 1925, pl. 3, fig. 5*a*; V.20041*a*, Chandler, 1925, pl. 3, fig. 5*b*; V.43737) and Bed 10 east of Beckton Bunny (V.42121, *a*).

Brasenia oblonga Chandler

(Pl. 25, figs. 44–46)

1925. *Brasenia oblonga* Chandler, p. 23, pl. 3, fig. 6.

Diagnosis. Seed elongate, rounded cylindrical, somewhat truncate at the apex, raphe forming a longitudinal ridge, aperture for embryotega large. Surface tubercled especially at base and along raphe ridge. Also with obscure longitudinal ridges. Length, 1·75 mm.; breadth, 0·9 to 1 mm.

Holotype. Brit. Mus. (N.H.), No. V.20043.

Description. No additions to this are needed.

Remarks. Both specimens had lost the embryotega.

Family Menispermaceae

Section Cocculeae Diels

Subsection Cocculineae Diels

Genus ***PALAEOSINOMENIUM*** Chandler, 1961 : 159

Palaeosinomenium obliquatum (Chandler)

(Pl. 25, figs. 47–50)

1925. *Menispermum obliquatum* Chandler, p. 24, pl. 3, fig. 9*a*, *b*.

Diagnosis. Endocarp curved somewhat obliquely, ventral margin slightly concave. Radially aligned ridges conspicuous outside the horse-shoe shaped ridge and on the marginal flange. Foramen between the limbs elongate, its lower end well above a line drawn between the extremities of the two limbs of the endocarp. Diameter about 3 by 4 mm.

Holotype. Brit. Mus. (N.H.), No. V.20049 (now shattered).

Remarks. Although the holotype is now much shattered, the characters are also shown by the fresh but imperfect material here illustrated. In the light of fuller experience the species is transferred to the fossil genus *Palaeosinomenium* which is defined as having a more oblique endocarp and a more elongate foramen than the living *Sinomenium* and *Menispermum*. *P. obliquatum* is smaller than *P. venablesi* (Chandler, 1961 : 159, pl. 16, figs. 9–13) and somewhat smaller than *P. pulchrum* (Chandler, 1961 : 329, pl. 33, figs. 5–7) which it very closely resembles but it also has a relatively narrower marginal flange than *P. pulchrum*.

Family Lauraceae

Genus?

(Pl. 25, figs. 51, 52)

Description. *Berry:* One-carpelled, probably originally subglobose, compressed dorsiventrally in fossilization, seated on a shallow cupule or swollen flattened peduncle, about 3 mm. in diameter, the scar of attachment on the berry about 1·8 mm. in diameter. Epicarp shining, 0·025 to 0·05 mm. thick, with scattered circular depressions, formed of a layer of equiaxial cells which are slightly convex superficially and about 0·016 mm. in diameter. Mesocarp (heavily impregnated with amorphous pyrites as in the London Clay fossils) varying considerably in thickness owing to uneven contraction on drying or crushing, probably averaging originally about 1·5 to 2 mm., its structure obscure. Endocarp 0·15 mm. thick, pointed at the apex, rounded conical, formed of columnar cells in section which are about 0·016 mm. broad. Testa and chalaza not seen but seed probably conforming to the outline of the endocarp the chalaza occupying the base of the rounded conical locule. Transverse diameter of berry (as crushed), 5·6 mm.; height (reduced by compression), 3·5 mm.; diameter of endocarp (not crushed), 3·3 mm.; height of endocarp, 2·6 mm.

Remarks and affinities. Whereas the relationship to Lauraceae is clear, without more and better material no satisfactory generic determination is possible. Clearly the specimen belongs to a small fruited genus with thick endocarp and small cupule (or swollen flattened peduncle). *Cinnamomum*, *Litsea*, and *Lindera* appear to be possible relationships. The circular depressions of the epicarp occur in *Cinnamomum*. C. Reid records leaves of *Cinnamomum* but without figures or descriptions. His specimens are not extant (Reid & Groves, 1921 : 178).

Family Droseraceae

Genus ***ALDROVANDA*** Monti

Aldrovanda ovata (Chandler)

(Pl. 26, figs. 53–55)

1925. *Nuphar ovatum* Chandler, p. 22, pl. 3, fig. 3*a*, *b*.
1926. *Aldrovanda ovata* (Chandler) Reid & Chandler, p. 113, pl. 6, figs. 24–26.

Holotype. Brit. Mus. (N.H.), No. V.17485.

Remarks. The discovery of the true relationship of these seeds by Docturowsky following upon work on living *Aldrovanda* by Nikitin and Korzhinsky is reported by Reid & Chandler (1926: 112). Specimens (V.17485–87) from Hordle (precise locality and horizon not specified) were figured by Chandler (1925) and by Reid & Chandler (1926). Also from an unspecified horizon are V.20053*a*,*b*. V.42130 is from Bed 10 east of Beckton Bunny and V.20052 from Bed 31. The same species characterized by its long neck, conspicuous apical mucro, marked raphe ridge and

relatively smooth surface, with a thick testa of two coats together measuring nearly a quarter of the diameter of the seed occurs at Colwell Bay in beds presumed to have been Lower Headon (V.42124, V. 42127) and in the *Limnocarpus* Band (V.42128–29). Some seeds both from Hordle and Colwell show the small circular plug closing the narrow neck. It has a central short thick mucro associated with the micropyle from which small convex equiaxial cells diverge over its outer surface increasing in size towards the circumference of the plug. Hilum at the margin of the plug. Dimensions of a number of seeds are as follows : 1) Length of seed, 1·75 mm. ; breadth, 1·35 mm. ; length of neck, 0·25 mm. 2) Length, 1·76 mm. ; breadth, 1·4 mm. ; length of neck, 0·3 mm. 3) Length, 1·9 mm. ; breadth, 1·25 mm. ; length of neck, 0·25 mm. 4) Length, 2 mm. ; breadth, 1·25 mm. ; length of neck, 0·25 mm. 5) Length, 1·75 mm. ; breadth, 1·25 mm. ; length of neck, 0·25 mm. 6) Length, 2 mm. ; breadth, 1·25 mm. ; length of neck, 0·3 mm. The average length of seeds is 1·83 mm. ; average breadth, 1·28 mm. i.e. relatively longer in proportion to the breadth than the specimens from Hordle measured by Reid & Chandler (1926 : 113).

Family Hamamelidaceae

Genus ***EOLIQUIDAMBAR*** nov.

Diagnosis. Agglomerate fruiting head with deep areoles. Carpels splitting into two equal valves which are not produced into awns.

Type Species.—*Eoliquidambar hordwellensis* n. sp.

Eoliquidambar hordwellensis n. sp.

(Pl. 26, figs. 56–59)

Diagnosis. That of the genus.

Holotype. Brit. Mus. (N.H.), No. V.42131*a*.

Description. *Fruiting Head :* Pedunculate, woody agglomerate, ovoid, formed of about eighteen to twenty-five deeply hollowed polygonal areoles each holding a single fruit. Wall between areoles thick, formed of woody fibres radiating from the axis of the fruit. Surface of these walls covered by a shining wrinkled epidermis, the wrinkles parallel with the margins of the areoles. Each wall shows a conspicuous median furrow at the surface, the furrows indicating the plane of fusion between the walls of adjacent areoles. Length of the ripe fruiting head, 17·5 mm. ; transverse diameter, 12·5 mm. Diameter of areoles at surface about 7·5 to 8 mm.

Fruitlets : Capsular, probably two-loculed, splitting at the apex into two valves which are not produced into awns. At the surface of the head the valves are crescentic in outline and are covered by a light coloured shining wrinkled epidermis formed of oblong cells, 0·01 mm. in greatest diameter, aligned parallel with the crescents at the middle of the valves and at right angles to them at the margins. Endocarp and seeds not seen. Length of crescents, 3·5 to 4·5 mm. ; breadth, 1·5 mm.

Remarks. In addition to the holotype there are immature fruiting heads: V.42131 is from Bed 10 between Beckton Bunny and Long Mead End and V.42132 from Bed 10 east of Beckton Bunny. The heads even in the immature condition are easily distinguishable from *Protoaltingia hantonensis* by the single pair of crescentic valves in each areole whereas in *Protoaltingia* even in young heads four knob-like valves are seen. The fibrous agglomerate character and the capsular fruits in the areoles indicate the family Hamamelidaceae section Altingieae. That the absence of awns at the apex of the fruits is an original feature and not due to abrasion is clearly indicated by the well preserved unbroken continuous epidermis covering the external margins of the valves. All living species of *Liquidambar* seen have long persistent styles which form gradually attenuated awns to the valves on dehiscence of the fruit while the margins of the areoles have a complex lobed structure quite unlike the smooth continuous surface of epidermis seen in the fossil. At the same time the mode of dehiscence of the fossil fruitlets into two valves is like that of *Liquidambar*. In this genus dehiscence is septicidal and the endocarps are persistent. The mode of dehiscence is not shown in the fossil and there is no evidence whether or not the endocarps are shed. In *Altingia* and *Protoaltingia* although the styles do not form awns dehiscence is in two planes, septicidal and loculicidal, hence the apex of the fruit is four-partite giving rise to the four knob-like valves mentioned above. It appears, therefore, that the fossil does not agree in all respects with *Altingia*, *Protoaltingia* or *Liquidambar* and it has been referred to a new genus *Eoliquidambar*.

Genus ***PROTOALTINGIA*** Chandler

Protoaltingia hantonensis Chandler

(Pl. 26, fig. 60)

1925. *Liquidambar* sp. Chandler, p. 25, pl. 4, fig. 1.
Protoaltingia hantonensis Chandler (in press), pl. 9, figs. 18–24; pl. 28, figs. 6–8.

Description. *Fruiting head:* Always so much abraded that the complete head is not preserved so far as is known at Hordle, but the specimen (V.20054) originally figured appears to have been ovoid although the long axis was erroneously oriented transversely. Agglomerate, with numerous funnel-like alveolae showing fibrous but somewhat cavernous walls the bases only remaining. These alveolae hold the worn down persistent fruitlets, one in each alveole. Largest fragment now preserved about 5 to 7 mm. in diameter.

Fruitlets: Capsular, two-loculed with antero-posterior locules formed of transverse fibres, elongate as seen in transverse section at right angles to the septum. Septicidal as shown by the curvature and separation of the walls at the septum. Evidence of loculicidal dehiscence almost destroyed by the wearing away of the distal ends of the fruit walls but indicated in one or two alveolae by the thinning and curvature of the walls in the plane at right angles to the septum.

Remarks. With the help of well-preserved material from the Bournemouth Beds these fragmentary remains can be better understood than in 1925 when they

were erroneously referred to *Liquidambar* itself through lack of understanding of the characters of the fossil combined with lack of knowledge of the living genus. The reference to Hamamelidaceae was correct. The account of the Bournemouth fruits is in the press. The Hordle specimens despite their poor condition agree with them in the characters seen. The elongate form of the fruitlets at right angles to the septum in transverse section allies them with *Protoaltingia hantonensis* and not with *Eoliquidambar hordwellensis* (p. 120). In addition to the figured fruit (now more broken) and V.20056 from the contemporary channel west of Long Mead End, there are also a few fragmentary heads from Bed 10, east of Beckton Bunny (V.20055, V.42133).

Family Rosaceae

Genus ***RUBUS*** (Tourn.) L.

Rubus acutiformis Chandler

1925. *Rubus acutiformis* Chandler, p. 26, pl. 4, fig. 2.
Rubus acutiformis Chandler : Chandler (in press), pl. 4, figs. 36–40.

There is nothing to add to the descriptions already published except that the endocarps occur in the greatest abundance in Bed 10 at the cliff base below Hordle House (V.20057–58, V.42134) and more rarely east of Beckton Bunny (V.42135). Specimens from Studland (in press), Bournemouth Freshwater Beds and Cliff End (awaiting publication) appear to be identical but the Hordle specimens are much better preserved than those from other localities.

Family Leguminosae?

Genus?

(Pl. 26, fig. 61)

Description. *Seed :* Smooth broadly subovoid or subglobular having a very slight and inconspicuous bisymmetry, probably splitting down one side in the plane of symmetry where a finished suture can be seen. Hilum marked by an obscure projection on the margin. Surface of fine equiaxial cells, 0·01 mm. in diameter, the testa compact 0·2 to 0·4 mm. thick, becoming thinner towards the hilum, columnar in section the fine columns, about 0·01 mm. broad and apparently formed of short cells placed accurately end to end. Length of seed, 4·5 mm. ; breadth, 4 mm. ; thickness rather less than breadth but as the seed has burst it cannot be measured accurately. The seed shows no outstanding readily recognizable characters, but the general appearance and testa structure suggest Leguminosae.

Genus?

(Pl. 26, fig. 62)

Description. *Seed :* Oval in outline, much compressed, compression increased in fossilization so that the opposite walls are now in contact, having a small marginal

circular hilum, 0·25 mm. in diameter, situated near the end of one of the long margins. This hilar scar is surrounded by a somewhat rough tumescent area on both surfaces. Elsewhere the surface of the seed is smooth and shining, one side showing an obscure curved groove sub-parallel with the circumference, its extremities arising at the hilar region. Testa superficially pitted, pits 0·004 to 0·005 mm. in diameter, somewhat obscured over much of the surface by tension fissures and striae. Thickness of testa 0·15 to 0·25 mm., formed of radially aligned cells having an obscure columnar appearance. Inner surface of convex equiaxial cells 0·1 mm. in diameter. Length of seed, 5·5 mm. ; breadth, 3·75 mm. ; thickness, 1 mm.

Remarks and affinities. One seed broken obliquely into two fragments, with a third small fragment missing on the dorsal margin. The form of the seed and character of the hilum suggest possible relationship with Leguminosae, but the nearer affinities have not been found. There is no distinct inner coat inside the columnar coat as in *Acacia* or *Albizzia* nor is the testa conspicuously columnar as in these and many other Leguminosae seeds.

Family Rutaceae

Genus ***ZANTHOXYLUM*** Linnaeus

Zanthoxylum hordwellense n. sp.

(Pl. 26, figs. 63, 64)

1925. *Zanthoxylon* cf. *ailanthoides* Sieb. & Zucc. : Chandler, p. 26, pl. 4, fig. 3*a*, *b* ; text-fig. 9.

Diagnosis. Seed with very slightly convex ventral margin, sides less inflated than living *Z. ailanthoides*. Surface with concentric wrinkles but few or no connecting ridges. Orifice to raphe canal ventral not basiventral. Length of seed, 2·25 to 4·5 mm. ; breadth, 2·25 to 3·5 mm. ; thickness, 1·85 to 2·75 mm.

Holotype. Brit. Mus. (N.H.), No. V.20059.

Description. *Seed :* Semi-anatropous, gibbous in outline having the ventral margin slightly convex, the dorsal rounded. Somewhat laterally flattened especially on each side of the ventral margin which is occupied by an elongate-triangular depressed hilar scar. Chalaza basal on the ventral side of the longest axis of the seed, marked by a large circular internal aperture (V.20059*a*) ; raphe canal prominent with a conspicuous orifice at the lower end of the hilar scar (Pl. 26, fig. 64) ; micropyle terminal on the ventral margin at the opposite end of the scar to the raphe orifice ; epidermis thin, shining, black, ornamented with a few concentric wrinkles and fine polygonal equiaxial pits ; within is a thick coat formed of equiaxial cells. Dimensions of seeds : 1) Length, 3·5 mm. ; breadth, 3 mm. ; thickness, 2·75 mm. 2) Length, 4 mm. ; breadth, 3 mm. ; thickness, 1·85 mm. ; length of hilar scar, 3 mm. 3) Length, 3·25 mm. ; breadth, 2·5 mm. ; thickness, 2·25 mm. ; length of hilar scar, 2·5 mm. 4) Length, 4·5 mm. ; breadth, 3·5 mm. ; thickness, 2·25 mm. Other small seeds varied in length or breadth from 2·25 to 2·75 mm. A typical scar measured 0·65 by 0·19 mm.

Remarks and affinities. Seeds fairly abundant, although very liable to decay,

occurring in Bed 10 below Hordle House (V.20059–60) and east of Beckton Bunny (V.42136). Usually the thin black epidermis has been destroyed and the thick inner integument is heavily impregnated with pyrites. It was pointed out (Chandler, 1925 : 27) that there is a close resemblance to *Zanthoxylum* (*Fagara*) *ailanthoides* Sieb. & Zucc. from which the fossil differs in the rarity or absence of transverse ridges connecting the concentric wrinkles, in its lesser degree of inflation, in its less convex ventral margin and its ventral orifice to the raphe canal as contrasted with the basiventral orifice of the living. Additional fossils since found merely increase the known variation in size of the species which further experience suggests deserves a distinct name. It is therefore called *Z. hordwellense*.

Zanthoxylum compressum Chandler

(Pl. 26, figs. 65–67 ; Text-fig. 3)

1925. *Zanthoxylon compressum* Chandler, p. 28, pl. 4, fig. 5.

Diagnosis. Seed rounded subquadrangular in outline, broadest dorsiventrally. Hilum very short, concave. Length of seed parallel with hilar scar, 3·25 to 3·5

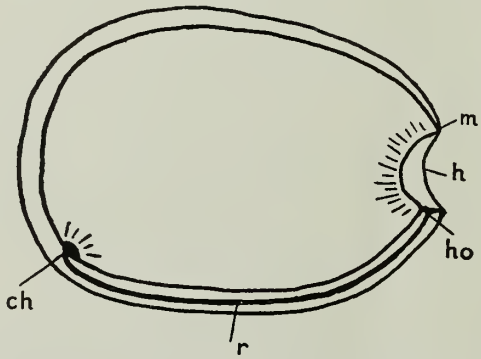

Fig. 3. *Zanthoxylum compressum* Chandler. Longitudinal section through a seed to show relative positions of hilar scar (*h*), hilar opening (*ho*), raphe (*r*) and chalaza (*ch*). × 12 approx.

mm. ; maximum diameter, 3·75 to 4 mm. approximately at right angles to scar.

Holotype. Brit. Mus. (N.H.), No. V.20061.

Description. (Slightly emended) *Seed :* Semi-anatropous, rounded subquadrangular in outline, broadest dorsiventrally, much compressed. Ventral margin short, concave, occupied by the sunk subtriangular hilar scar. Opposite margin rounded, the internal chalaza being situated where this rounded margin gradually merges into the lower long lateral margin of the seed (as revealed by a break in the testa of the second specimen). Raphe, connecting the lower broad end of the hilar scar with the chalaza, a long canal which traverses the testa within the long lower

lateral margin of the seed. Outer surface black and shining ornamented with finely crenulate pits like those on the middle black coat of some living species. A second seed (V.42137) was abraded and rough superficially but retained a tiny fragment of a black shining superficial layer with slightly convex, equiaxial angular cells about 0·05 mm. in diameter. These cells are separated by fine hair-like straight raised walls. Tegmen thin, of equiaxial cells 0·016 to 0·025 mm. in diameter. Length of holotype (parallel with hilar scar), 3·5 mm.; breadth (maximum diameter), 4 mm. Length of second abraded seed, 3·25 mm.; breadth (maximum diameter), 3·75 mm.; thickness, 1·5 mm. In this specimen the hilar scar was considerably shorter than in the first seed. Thickness of wall where broken at chalaza, 0·3 mm.

Remarks. Two seeds clearly related to *Zanthoxylum* distinguished specifically by the broad subquadrangular rounded form and very short hilum.

Genus ***PHELLODENDRON*** Rupr.

Phellodendron costatum Chandler

1925. *Phellodendron costatum* Chandler, p. 28, pl. 4, fig. 6*a–c*.
Phellodendron costatum Chandler: Chandler (in press), pl. 10, fig. 1.

Diagnosis. Seed sometimes with knob-like subapical constriction. More inflated than any living species. Longitudinal ribs unusually well marked. Length, 3 to 3·5 mm., breadth, 1·8 to 2·25 mm.; thickness 1·8 to 2 mm.

Holotype. Brit. Mus. (N.H.), No. V.20062.

Emended Description. *Seed:* Semi-anatropous, subovoid, bisymmetric, with a more or less straight ventral margin and a rounded dorsal margin in the plane of symmetry; apex curved slightly towards the ventral side, sometimes with a knob due to an inconspicuous subapical constriction. Hilum strap-shaped, extending almost the whole length of the ventral margin, micropyle sunk in a depression at the apical end of the hilar scar i.e. on the knob when present; raphe canal opening at a foramen at the base of the hilar scar, short, curved; chalaza a large circular internal aperture at the end of the major axis of the seed away from the micropyle. Germination by splitting in the plane of symmetry; surface sculpture of numerous acute longitudinal ribs (about twenty-four were counted in one specimen) frequently connected by transverse spurs; finer structure of small cells equiaxial or transversely elongate at right angles to the ribs. Testa in section 0·3 mm. thick at the middle of the broad surface, formed of square cells about 0·02 to 0·025 mm. in diameter arranged in radial rows. Length of seed, 3 to 3·5 mm.; breadth, 1·8 to 2·25 mm.; thickness, 1·8 to 2 mm.

Remarks and affinities. In addition to the holotype there are four other seeds (V.42138–41). The species is now also known from the Dorset Pipe-clay Series at Arne (in press) and the Bournemouth Freshwater Beds at Sandbanks (awaiting publication). The form, character of hilum, raphe and chalaza and testa structure all relate these specimens to Rutaceae. Although the form and ornamentation in general and the strap-shaped hilar scar indicate *Phellodendron* as the nearest living

genus, the fossil seeds are clearly distinguished from any living or other fossil species by the greater degree of inflation, somewhat smaller size and more marked longitudinal ribs of the surface. On account of this last feature the name *P. costatum* was given.

Genus ***RUTASPERMUM*** Chandler, 1957 : 102

Rutaspermum ornatum (Chandler)

(Pl. 26, fig. 68 ; pl. 27, figs. 69–71)

1925. *Zanthoxylon ornatum* Chandler, p. 27, pl. 4, fig. 4*a*, *b* ; text-fig. 10.

Diagnosis. Seed broadly semilunate in outline with straight ventral margin slightly beaked at the micropyle, hilar depression up to three-quarters of the length of the seed. External surface ornamented with sinuous longitudinal ribs which occasionally branch and anastomoze, sometimes connected by short transverse ribs. Testa conspicuously pitted, smooth around the hilar depression. Length of seeds, 4 to 7·25 mm. ; breadth, 3·5 to 4 mm. ; thickness, 2·5 to 3 mm.

Neotype. Brit. Mus. (N.H.), No. V.42142. (Holotype decayed.)

Description. *Seed :* Semi-anatropous, broadly semilunate in outline, inflated. Ventral margin more or less straight, slightly beaked above, occupied in the upper part by the elongate narrowly triangular hilar depression which extends from the apex for nearly three-quarters of the length in some specimens, two-thirds of the length in others and usually well below the middle. Chalaza marked internally by a large orifice situated at the extremity of the longest axis remote from the apical beak. External surface ornamented with sinuous longitudinal ribs which occasionally branch and anastomoze or are sometimes connected by short transverse ribs. Surface formed of equiaxial or elongate pits, 0·025 to 0·03 mm. in diameter. Testa about 0·3 to 0·4 mm. thick on the dorsal side, thicker on the ventral side. Completely surrounding the hilar depression is a smooth somewhat flattened area. A few seeds show traces of a thin black shining pitted epidermis but this is almost invariably destroyed. Length of seeds, 4 to 7·25 mm. (frequently about 4·5 mm.) ; breadth, 3·5 to 4 mm. ; thickness, 2·5 to 3 mm. Typical measurements are : 1) Length, 5·5 mm. ; breadth, 4 mm. ; thickness, 2·5 mm. 2) Length, 4·5 mm. ; breadth, 3·5 mm. ; thickness, 2·5 mm. 3) Length, 5·5 mm. ; breadth, 4 mm. ; thickness, 3 mm. 4) Length, 6 mm. ; breadth, 4·5 mm. ; thickness, 3 mm. 5) Length, 5 mm. ; breadth, 3·5 mm. ; thickness, 3 mm.

Remarks and affinities. Numerous seeds (cf. V.42146) almost invariably preserved in a soft pyrites mud which is peculiarly liable to rapid decay on exposure to air. At first these seeds were referred to the genus *Zanthoxylum* but it is now clear that no living representative of *Zanthoxylum* has such clearly defined regular superficial ornamentation, hence they are now relegated to the form-genus *Rutaspermum* Chandler, no comparable living genus having been found. The species is distinguished clearly from all others from the south coast deposits by the combined characters of size and smooth unornamented area immediately surrounding the hilar scar.

Family Burseraceae

Genus ***PALAEOBURSERA*** Chandler, 1961 : 202

Palaeobursera lakensis Chandler

(Pl. 27, figs. 74, 75)

Palaeobursera lakensis Chandler (in press), pl. 10, figs. 20–26.

Description. *Pyrene :* Pointed-ovate in outline, subtriangular in transverse section, dorsal surface convex, ovate ; ventrilateral surfaces meeting to form a median ventral longitudinal angle especially clear in the upper two-thirds. Angle pierced about 2 mm. from the apex (i.e. below the middle) by a curved transverse aperture, concave towards the apex of the fruit, for the ingress of the funicle to the placenta. Germination valve occupying the upper two-thirds of the dorsal surface. Wall formed superficially of equiaxial pits about 0·03 to 0·05 mm. in diameter over most of the surface but becoming narrower and elongate along the ventral angle where they may be 0·016 mm. broad and 0·03 to 0·05 mm. long. Thickness of wall on dorsal side 0·1 mm. Small cells, about 0·01 mm. in diameter can be seen forming the walls of the large external pits. Length of endocarp, 3·5 mm. ; breadth, 2·75 mm. ; thickness, 1 mm.

Remarks and affinities. A perfect specimen (V.42147) and three other fragments (V.42148), one the rounded end of a larger pyrene. A comparison with pyrenes from the Dorset Pipe-clay Series of Lake (in press) and the Bournemouth Freshwater Beds at Sandbanks (awaiting publication) indicates that the Hordle specimens belong to the same species. It must be noted that the best preserved Lower Headon pyrene is a broad example, uncrushed (as is often the case in the Hordle fossils) and therefore more inflated. Its surface is well preserved unlike the older specimens which are both abraded and sand pitted, but identical pits have been seen in a pyrene from Sandbanks and in other fragments. The Hordle pyrene is therefore referred to *P. lakensis* Chandler.

Family Anacardiaceae

Section Spondieae

Genus?

(Pl. 27, figs. 72, 73)

Description. Part of a thin-walled fruit with obscure cell structure and rough external surface. Two compartments are occupied by bolster-shaped closely adpressed bodies which may be resin sacs as in *Dracontocarya glandulosa* from the Dorset Pipe-clay Series (Chandler (in press), pl. 12, figs. 10–21). These bodies appear to have been partially released by maceration so that they resemble lines of parietal seeds. The exposed surface is ornamented by a network of fine ridges forming irregular polygonal areas about 0·025 to 0·05 mm. in diameter. The fruit

fragment is 2·5 by 3 by 1·5 mm. The sacs vary, those measured were respectively : 0·4 by 0·25 mm. ; 1·2 by 0·6 mm. at one end and 0·3 mm. at the other end ; 0·6 by 0·2 mm. ; 1 by 0·3 mm.

Remarks. No true locules or seeds have been seen nor is the form of the perfect fruit known. While the presence of the resin sacs suggests relationship with Spondieae, the fragment cannot be identified with *Dracontocarya glandulosa* to which it bears a general resemblance as the endocarp in that species is much more fibrous and its sacs are larger (about 0·912 to 1·9 mm. long).

Family Icacinaceae

Genus *NATSIATUM* Buch.-Ham.

Natsiatum eocenicum Chandler

1925. *Natsiatum eocenicum* Chandler, p. 29, pl. 4, fig. 7*a–d* ; text-fig. 11.
Natsiatum eocenicum Chandler : Chandler (in press), pl. 13, figs. 6–16.

The endocarps have been redescribed (see above) in an account of the species from the Dorset Pipe-clay Series and some fresh Hordle material illustrated for comparison. V.40614 (the neotype), V.42151–52 (fragments) are from Bed 10 east of Beckton Bunny. V.40615–16 from Bed 10 below Hordle House. The original holotype, V.42149, (Chandler, 1925, pl. 4, fig. 7*b–d*) is now much broken and decayed as is V.42150 (Chandler, 1925, pl. 4, fig. 7*a*). Both were from the contemporary stream channel west of Long Mead End.

? *Iodes* sp. (or ? *Natsiatum* sp.)

(Pl. 27, figs. 76, 77)

1925. *Iodes* sp., Chandler, p. 29, pl. 4, fig. 10 ; text-fig. 12.

Description. *Endocarp :* Incomplete, only the funicular margin being preserved. Longitudinal section narrow-ovate, the lateral funicular canal gradually broadening at the apex ; placenta subapical on the funicular margin marked externally by a pair of short horn-like processes which flank it. Walls thick and woody. External surface ornamented by a few conspicuous ridges which branch and anastomoze to form a very coarse network. Locule lining thin, semitranslucent, formed of inflated equiaxial cells. Length of fragment, 9·75 mm. ; incomplete breadth, 4 mm. ; thickness, 5·75 mm.

Remarks. V.20063, Bed 10 below Hordle House. Relationship to Icacinaceae indicated by the character of the funicular margin. The form of the longitudinal section recalls *Natsiatum herpeticum* Ham. and species of *Iodes*. The convex cells of the locule lining recall *Natsiatum* rather than *Iodes* but the relationship must remain uncertain without better material.

Genus ***IODES*** Blume

Iodes ? hordwellensis n. sp.

(Pl. 27, figs. 78, 79 ; Text-fig. 4)

DIAGNOSIS. Endocarp broader than long, much inflated. Ridges of surface ornamentation somewhat rounded, not acute like those of *Natsiatum eocenicum*. Length, 6·5 mm. ; breadth, 8·5 mm. ; thickness about 5 mm.

HOLOTYPE. Brit. Mus. (N.H.), No. V.42153.

DESCRIPTION. *Endocarp :* Similar superficially to that of *Natsiatum eocenicum* but broader than long and much more inflated. Bisymmetric about a plane passing through funicle, attachment and style. Funicular margin having a rounded rib which broadens conspicuously over the subapical placenta. Opposite margin with a

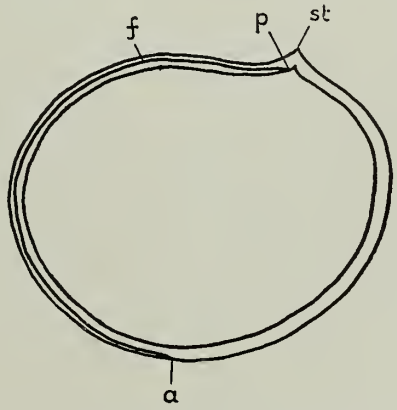

FIG. 4. *Iodes ? hordwellensis* n. sp. Diagram to show endocarp in longitudinal section. (*st*) style, (*p*) placenta, (*f*) funicle, (*a*) attachment. ×4 approx.

sharper ridge. Style apical, marked by a small knob. External surface with a network of rounded ridges less prominent and acute than in *N. eocenicum*, surface formed of fine equiaxial cells, finer than those of *N. eocenicum*. A small fragment (V.42154) of a second specimen? shows a similar curvature. On its inner surface there are obscure digitate cells covered by a thin integument bearing small papillae. Length of endocarp (possibly slightly reduced by distortion), 6·5 mm. ; breadth, 8·5 mm. ; thickness (possibly slightly increased by distortion), 5 mm.

REMARKS AND AFFINITIES. One endocarp and a fragment. The species is clearly distinguished by its broad transverse form and less sharp ridges from *Natsiatum eocenicum*. The appearance and papillae of the locule lining of the second specimen suggest relationship with *Iodes*, but the transversely broad form has not been seen in this genus. Hence the determination is regarded as provisional.

Genus ***ICACINICARYA*** Reid & Chandler, 1933 : 344

Icacinicarya transversalis n. sp.

(Pl. 27, figs. 80–82)

Diagnosis. Endocarp transversely-oval in outline. Style asymmetric on the broad apical margin, attachment near middle of broad basal margin. External surface with network of bold sharp ridges. Locule tubercled. Length of uncrushed valve, 10·25 mm. ; breadth, 14 mm.

Holotype. Brit. Mus. (N.H.), No. V.23420.

Description. *Endocarp :* Woody, transversely-oval in outline, somewhat compressed, bisymmetric about a plane which includes the two major axes and the funicle and style, dehiscing in this plane into symmetrical halves. Attachment near the middle of the broad basal margin, style asymmetric on the broad apical margin, so that a straight line drawn between these two organs divides the endocarp unequally. Funicle marginal within the thickness of the wall in the larger of the two unequal divisions described, placenta apical adjacent to the stylar canal, marked externally by a slight thickening of the margin ; seed pendulous, solitary. Endocarp from 0·3 to 0·35 mm. thick, hard and compact, formed of cells, 0·016 mm. in diameter arranged in a somewhat columnar manner as seen in sections of the wall, the " columns " in parts being somewhat oblique. External surface boldly ornamented by a network of sharp ridges, some of these given off from the margin with the funicle are longer, straighter and more conspicuous than the others. Locule tubercled, the tubercles formed by a coat of convex cells. Length of specimen, 10·25 mm. ; breadth, 14 mm. Length of a distorted endocarp, probably referable to the same species, imperfect ; breadth, 10 mm.

Seed : Represented by shrivelled and half-decayed testa, formed of equiaxial cells, somewhat irregular in shape and alignment, about 0·025 mm. in diameter.

Remarks and affinities. A valve (V.23420) from Bed 10 below Hordle House having a small fragment missing on the funicular margin. Also a much distorted endocarp (V.23419). It was imperfect at the apex, with better preserved ornamentation than that of V.23420 but probably belonged to the same species. This imperfect specimen was dissected after it had been photographed ; it then showed the remains of the seed and the tubercles of the locule lining.

Form and structure indicate relationship with Icacinaceae. The broad oval form also seen in the smaller endocarps of *Iodes? hordwellensis* has not so far been found among living representatives of the family but occurs in fossil forms from the London Clay e.g. *Faboidea crassicutis* (Reid & Chandler, 1933 : 341, pl. 16, figs. 3–10) and *Icacinicarya reticulata* (Chandler, 1961 : 225, pl. 22, figs. 25–34).

Icacinicarya becktonensis n. sp.

(Pl. 27, figs. 83, 84)

Diagnosis. Endocarp bisymmetric, subobovoid, funicular margin only slightly convex, opposite margin almost semicircular in plane of symmetry. Funicular

canal broad. Surface coarsely but very obscurely reticulate. Length of endocarp (slightly imperfect at style), 4 mm. ; breadth in plane of symmetry, 3 mm. ; thickness at right angles to plane of symmetry, 2·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.42155.

Description. *Endocarp :* subobovoid, bisymmetric, lateral funicle in plane of symmetry broad, incurving abruptly at the apex to the placenta. Margin carrying funicle only slightly convex, opposite margin almost semicircular in plane of symmetry. No evidence is preserved of short projecting horns or canals flanking the style at the apex, probably because the apex and outer walls of the funicular canal are abraded. Surface showing a few coarse rather obscure reticulations. Small coarsely digitate cells can be seen in patches. Wall (as preserved) 0·228 mm. thick.

Seed : Represented only by a few patches of testa or by impressions on a film of pyrites, formed of equiaxial angular cells about 0·013 mm. in diameter. A large circular scar with rimmed edge originally lay within the broken apex of the endocarp and clearly represented the hilum of the seed. Dimensions of seed somewhat smaller than those of the endocarp, too incomplete to measure.

Remarks. The specimen was originally perfect apart from its abraded condition which exposed the funicular canal. It subsequently collapsed showing the wall in section almost entirely replaced by amorphous pyrites except for a film of carbonaceous substance lining it outside and in. The species resembles *Icacinicarya pygmaea* (Chandler, 1960 : 226, pl. 34, figs. 118–121) in its somewhat gibbous outline with slightly convex funicular margin and highly convex opposite margin, but is more obovoid in shape than that species and considerably larger. There is no evidence of short apical canals flanking the style as in *I. pygmaea*. It is also distinguished from the subglobular endocarps of *I. bartonensis* (Chandler, 1960 : 227, pl. 34, fig. 122) by its larger size and subobovoid form.

Family Rhamnaceae

Genus ***RHAMNUS*** Linnaeus

Sub-genus ***FRANGULA*** Tourn. ex Hall.

Frangula hordwellensis n. sp.

(Pl. 27, figs. 85, 86 ; pl. 28, fig. 87)

1925. Rhamnaceae ? Genus ? sp. 2, Chandler, p. 31.
1926. Rhamnaceae Genus ? sp. 2, Chandler, pl. 5, fig. 2.

Diagnosis. Pyrene and seed together 3·5 to 5·25 mm. long ; 3·6 to 3·75 mm. broad. Oboval or suboboval in outline with emarginate distal end.

Holotype. Brit. Mus. (N.H), No. V.42156.

Description. *Fruit :* A globose berry 6·25 mm. long, 4 mm. broad in the one specimen found with obscure structure having two pyrenes (or cocci) preserved. Each pyrene formed of a single seed closely embraced by the endocarp except at

the extreme proximal end where it projects beyond the carpellary coat ; outline of pyrene oboval or suboboval but slightly asymmetric because one margin is a little longer than the other, conspicuously emarginate at the distal end, gently convex with a narrow median longitudinal concavity on one surface and an obtuse but clearly defined median longitudinal angle on the other ; formed superficially of concave equiaxial cells, 0·016 to 0·025 mm. in diameter, beneath which are several layers of fibres that diverge obliquely upward from the median angle on the one face, and sweep transversely across the gently convex face. Dimensions of two pyrenes from different fruits : 1) Length, 3·5 mm. ; breadth, 3·75 mm. 2) Length, 5·25 mm. ; breadth, 3·6 mm.

Seed : Anatropous with marginal raphe ; agreeing in shape with the closely investing endocarp but projecting at its proximal end as described. Hilar end with a deep elongate-oval hollow surrounded by a rim formed by an upstanding arillus or projection of the testa. Within the hollow is a median ridge parallel with the broad face of the seed. The raphe enters the testa at one end of the hollow and can be traced along the shorter lateral margin of the seed ; the micropyle is at the opposite end of the hollow. Testa black and shining, 0·2 mm. thick around the basal hollow, only about 0·1 mm. thick at the middle of the lateral margin, formed superficially of digitate cells, about 0·025 mm. in diameter, markedly columnar in section, the columns about 0·025 mm. broad, having uneven sinuous walls owing to the variation in diameter of the short cells, arranged end to end, of which they are formed. Seed cavity with a shallow median longitudinal furrowed angle (underlying the external furrow of the pyrene) from which the cells of the internal surface appear to diverge. Tegmen thin, semitranslucent, readily detachable, formed of elongate cells which produce parallel striae about 0·008 mm. apart near the lateral margins, elsewhere of equiaxial cells, 0·012 to 0·016 mm. in diameter. Chalaza a conspicuous thickened scar with branching fibres at the end of the tegmen which immediately underlies the emargination of the seed. Dimensions of seeds approximately those of the pyrenes.

Remarks and affinities. One fruit in a much decayed condition with two seeds preserved was originally described but is now completely decayed. One larger perfect detached seed and part of another (V.42157) have since been found which have added considerably to the knowledge of the structure recorded in 1925.

The endocarp is preserved only in patches on these seeds, the distintegrating processes of fossilization having separated testa and endocarp in a way difficult to effect in living material without maceration.

It is now clear that the relationship is with the sub-genus *Frangula* of the genus *Rhamnus*. Comparison has been made with *R. frangula* Linn. and *R. purshiana* DC. The more slender form and emarginate apex distinguish the fossil from either of these living species, but the general resemblance especially to *R. purshiana* is very close. *R. purshiana* is a native of the Rocky Mountains. The sub-genus *Frangula* is largely American occurring in both the east and west of North America and in South America also. Species are found in Europe, Central Asia, North Africa, the Canaries and the Azores, the mountains of South Europe, the Caucasus and Persia and in Japan.

Family Sabiaceae

Genus ***MELIOSMA*** Blume

Meliosma sp.

(Pl. 28, figs. 88, 89)

Description. *Endocarp:* One loculed, one seeded, ovoid, bisymmetric in a plane through the attachment and major axis, each broad face with a median broad rounded ridge which extends from the apex to about the middle. Attachment marked by a conspicuous circular aperture. Character of funicular canal not seen. Surface of endocarp showing equiaxial pits about 0·016 mm. in diameter; thickness of wall about 0·15 mm. of similar cells no definite alignment detected. Lining of endocarp of elongate cells with finely digitate walls their length rather obscure, breadth about 0·01 mm. Testa thin, semitranslucent, formed of inflated longitudinally elongate cells about 0·01 mm. broad, length obscure. Maximum diameter in plane of symmetry, 2·75 mm.; diameter at right angles to this in plane of symmetry, 2 mm.; diameter at right angles to plane of symmetry, 1·25 mm.

Remarks. Two endocarps now shattered but represented by remains with cell structure. They closely resemble material awaiting publication from the Bournemouth Beds and are similar in their small size. The highly characteristic digitate cells lining the locule confirm the ascription based on form and structure to the genus *Meliosma*.

Family Vitaceae

Genus ***PARTHENOCISSUS*** Planchon

Parthenocissus hordwellensis n. sp.

(Pl. 28, figs. 90–95)

1926. *Parthenocissus* sp., Chandler, p. 33, pl. 6, fig. 1*a–c*.

Diagnosis. Apex of seed flattened or scarcely furrowed, raphe somewhat sunk above the chalaza; chalaza oval, median, sunk. Ventral infolds more than three-quarters of the length of the seed, diverging upwards. Length of ripe seeds, 3·5 to 5 mm.; breadth, 2 to 3·5 mm.; thickness about 2 mm.

Holotype. Brit. Mus. (N.H.), No. V.20066.

Description. *Seed:* Obovate in outline, smooth, narrowed gradually to the stipitate base, apex slightly flattened or scarcely furrowed. Dorsal surface convex with a median oval slightly sunk chalaza passing abruptly into the narrow somewhat sunk raphe. Ventral angle about 90° when uncrushed, deep lateral depressions extend almost from the base for more than three-quarters of the length and diverge upwards. Surface pitted, pits separated from adjacent ones by their own diameter. Length of seed, 3·5 to 5 mm.; breadth, 2 to 3·5 mm.; thickness (uncrushed), 1·5 to 2 mm. A typical seed measured 4 by 2 by 2 mm. Smaller seeds about 2·75 by 1·6 by 1·5 mm. appear to be immature.

Remarks and affinities. The seeds being brittle are often broken. Several specimens (V.42161–64) including an immature seed have been found and a few fragments (V.20067). The species is closely comparable with the living *P. henryi* Hems.

A single seed of *P. hordwellensis* (V.42237) was found in the Barton Beds, Horizon A3, after the paper dealing with Barton plants was in proof. It is an internal cast in pyrites, 4·5 mm. long, 2·5 mm. broad. The ventral surface shows the infolds clearly but the chalaza on the dorsal side is obscured by a coarse crystalline efflorescence. The seed is shown for comparison with the Hordle material in Pl. 28, figs. 94, 95.

Genus ***AMPELOPSIS*** (L. C. Rich. in) Michx.

Ampelopsis rotundata Chandler

1926. *Ampelopsis rotundata* Chandler, p. 33, pl. 5, fig. 5*a–c*.

Diagnosis. Seed roundly obovate in outline, much inflated, apex rounded, base acutely pointed. Dorsal face rounded with raised convex oval chalaza and prominent raphe. Ventral face convex with short divergent deep wide infolds. Length of largest seed, 3·5 mm.; breadth, 3 mm. Length of smallest, 2·5 mm.; breadth, 2 mm.

Holotype. Brit. Mus. (N.H.), No. V.20068.

Remarks. Other material (V.20068*a*) a small immature seed and three incomplete specimens. All the seeds are from Bed 10 near Long Mead End.

Genus ***TETRASTIGMA*** Planchon

Tetrastigma lobata Chandler

(Pl. 28, figs. 96, 97)

1925. *Tetrastigma lobata* Chandler, p. 32.
1926. *Tetrastigma lobata* Chandler, pl. 5, fig. 3*a–c*.
? *Tetrastigma lobata* Chandler; Chandler (in press), pl. 15, figs. 35–38.

Diagnosis. Seed deeply grooved at apex, base tapering or broad and slightly stipitate. Median chalaza oval sunk, raphe narrow sunk. Both surfaces lobed, lobes of ventral surface on both sides and on raphe ridge. Length of seed, 5·5 to 9 mm.; breadth, 4 to 10 mm. in well developed seeds.

Holotype. Completely decayed as is all other material. See Chandler, 1926, pl. 5, fig. 3*b*, *c*.

Description. *Seed:* Obovate, roundly oblong or subcircular in outline, much compressed dorsiventrally, apex deeply grooved, base tapering or broad and slightly stipitate; dorsal face with small sunk median oval chalaza and narrow sunk raphe; surface deeply lobed, lobes radiating from the chalaza. Ventral face with longitudinal infolds from which rounded lobes diverge both over the sides and the raphe ridge. Surface pitted, testa columnar in section. Length of seed, 5·5 to 6·5 or

even 9 mm. ; breadth, 4 to 10 mm. An exceptionally small seed was 3 mm. long, 3·25 mm. broad. A typical seed was 6·5 mm. long, 5 mm. broad, 3 mm. thick, but the measurements were made after drying so that the seed had contracted to perhaps two-thirds of its original size.

Remarks. Three seeds of which two were figured in 1926 and one in the present volume. The mode of preservation was such that the species was peculiarly liable to decay. The relationship to living *Tetrastigma* was discussed by Chandler (1925 : 32) and a similar seed referred to *? T. lobata* was described from the Dorset Pipe-clay Series of Lake (in press). Kirchheimer describes a comparable species of *Tetrastigma* under the name *T. chandleri* from the Middle to Upper Oligocene of Saxony (Kirchheimer, 1957 : 324, 602, fig. 197*a–d*) which he states is relatively narrower in proportion to the length.

Family Dilleniaceae

Genus ***ACTINIDIA*** Lindl.

Actinidia sp.

(Pl. 28, fig. 98)

Description. *Seed :* A fragment showing the rounded apex but unfortunately neither the raphe, micropyle or hilum are preserved. The testa has coarse hexagonal external pits, 0·05 to 0·1 mm. in diameter, delimited by rounded walls with median suture line along which it tends to break. Internally there are corresponding convexities characteristic of *Actinidia*. The fragment is 1·5 mm. long and its maximum breadth is 1 mm.

Remarks. The seed in spite of its imperfect condition appears to be identical with better preserved material from Bournemouth awaiting publication in which all the distinctive characteristics of *Actinidia* are shown.

Family Theaceae

Section Theae

Genus ***GORDONIA*** Ellis

Gordonia minima Chandler

(Pl. 28, figs. 99–102)

1926. *Gordonia minima* Chandler, p. 34, pl. 6, fig. 3*a*, *b* ; text-fig. 16.

Diagnosis. Capsule pointed-ovoid, scar of attachment small so as scarcely to truncate the base. Sutures of five valves forming thin longitudinal ridges. Length of capsule, 8·5 to 10 mm. ; breadth, 4 to 5·75 mm.

Holotype. Brit. Mus. (N.H.), No. V.20070.

Description. *Fruit :* A five-loculed woody capsule with five loculicidal thick-walled valves which remain attached to one another and to the receptacle at the base ; capsule pointed-ovoid the apex much attenuated, scar of attachment small,

remains of receptacle persistent, prominent, circular or pentagonal. The sutures of the valves form thin longitudinal external ridges. Valves triangular in cross section, before dehiscence united throughout their length by thin septa to a five-angled columella. On dehiscence the septa break away at the base along a curved line leaving the valves separated from the columella. Length of fruit, 8·5 to 10 mm. ; breadth, 4 to 5·75 mm.

Remarks and affinities. Numerous specimens in addition to those figured, almost always incomplete above, and some detached valves (cf. V.20071, V.20071*c*, V.20072, V.42166) only two virtually perfect fruits having been seen. The characters are those of *Gordonia* but no such small living species is known, the nearest in size being *G. lasianthus* Linn. (length, 13·5 mm.) from swamps of Mexico and Florida. The genus also occurs in China, the Himalayas, Ceylon, Further India and the East Indies.

Gordonia truncata Chandler

1926. *Gordonia truncata* Chandler, p. 35, pl. 6, fig. 4*a*, *b* ; text-fig. 17.

Diagnosis. Fruit ovoid not as conspicuously attenuated to the apex as is *G. minima*. Base truncate by the large scar of attachment which is much broader than in *G. minima*. Sutures of valves smooth externally not ridged. Length of fruit, 9 mm. ; diameter (compressed), 3·5 by 5·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.20073.

Remarks. Seven additional fruit bases (V.42167) have now been recognized by the great breadth of the scar of attachment. For a discussion of the relationship of the species see Chandler (1926 : 35).

Section Taonabeae

Genus ***EURYA*** Thunb.

Eurya becktonensis n. sp.

(Pl. 28, fig. 103)

Diagnosis. Seed transversely oval in outline with reniform cavity (inferred from form and pitting) the micropylar limb apparently broader at its end than the other. Hilum marginal somewhat nearer to the micropylar than to the chalazal limb. Testa thickened laterally near the hilum by a conspicuous patch of coarsely pitted tissue. Dimensions of seed, 2 by 1·25 mm.

Holotype. Brit. Mus. (N.H.), No. V.42168.

Description. *Seed :* Bisymmetric, transversely oval in outline (dorsal margin slightly imperfect), inflated. Cavity (as inferred from form and pitting) reniform the micropylar limb being slightly broader at its extremity than the other. Hilum an elongate-oval depression on the broad margin between the limbs. Micropyle near one end of the same margin terminating the broad limb and indicated superficially by a point around which the surface pits are small and radially aligned.

Around the hilum (seen on one well preserved surface of the seed) is a thick, coarsely pitted, triangular patch of tissue the inner point of the triangle lying nearer to the chalaza than to the micropylar limb. Pits on the thickened area mostly equiaxial and from 0·057 to 0·1 mm. in diameter. Whole surface of testa deeply and coarsely pitted, the rows of pits lying parallel with the dorsal margin of the seed and with the curvature of the seed cavity. Over the middle part of the curve there are six or seven very regular rows of pits the largest about 0·1 by 0·076 mm. in diameter. Many of the pits are elongate radially. Over the chalazal limb the pits become long and narrow and on its ventral side their walls are scarcely prominent perhaps because only in this part of the testa is the outer wall of the pit preserved obscuring the cavity usually exposed elsewhere by the collapse and abrasion of this wall. Maximum diameter of seed in plane of symmetry, 2 mm. ; diameter at right angles to it, 1·25 mm. ; thickness at right angles to plane of symmetry, 0·75 mm.

Remarks. One seed only of which the details of structure are clearly preserved on one surface but obscured by the poorer preservation on the other.

The size and form of the pitted seed with its reniform cavity place it in the Taonabeae a section of the Theaceae comprising trees and shrubs. A similar reniform cavity has been seen in *Eurya* and *Adinandra* but the fossil more resembles the thinner-walled *Eurya* than the latter genus. In *Eurya*, however, there appears to be considerable variation in the form of the seed cavity in different species which suggests that there may be some confusion among the living herbarium material of which unfortunately only a very limited amount could be dissected. Thus *E. japonica* R. D. Oldham No. 92 Nagasaki with seeds about 1·2 by 1·5 and 1 by 1·5 mm. in diameter has a reniform seed cavity closely comparable with that of the fossil whereas *E. japonica* var. *nitida* Dyer from West Borneo, Mondi 267, has a hooked cavity with one long and one short limb and is unlike the fossil. *E. japonica* ranges from Japan, China and the East Indies to the Indian Archipelago while allied species (section *Proteurya*) are found in the Sandwich Islands, Malaya and Ceylon. The seed has been named *Eurya becktonensis*.

Genus ***CAMPYLOSPERMUM*** Chandler, 1925 : 16

Campylospermum hordwellense Chandler

(Pl. 28, figs. 104–107)

1925. *Campylospermum hordwellense* Chandler, p. 16, pl. 1, fig. 6*a–c* ; text-fig. 4.

Diagnosis. Fruit with five to eight (or more?) radially arranged seeds in a single row pendulous from an axile apical placenta. Length of fruit about 4 to 5 mm. Seeds bisymmetric, flattened, oblong or oboval in outline, splitting in the plane of symmetry with U-shaped cavity having very unequal limbs. Condyle between limbs occupied by long raphe canal from about one-quarter to one-half the length of the seed. Testa formed externally of coarse inflated cells, internally compact of several layers of small rectangular cells. Seed about 4 mm. long, 1·75 to 2 mm. broad.

Holotype. Brit. Mus. (N.H.), No. V.20034 (much decayed), Neotype V.20035.

DESCRIPTION. *Fruit:* Globular or subglobular, apex incomplete, base with short stalk (erroneously regarded as style in 1925), lateral walls rarely preserved but showing rounded secreting cells, inner thin layers more frequently seen with remains of longitudinal fibres branching upwards at acute angles. Plurilocular, commonly three-loculed with a single row of five to eight (or more?) pendulous seeds arranged radially around a fibrous axis. Placentation axile, apical. Length of fruit at least 4 mm.; breadth, 3·5 to 5 mm. (without lateral walls).

Seed: Bisymmetric approximately, oblong or oval in outline, laterally flattened by mutual pressure of adjacent seeds in berry, splitting for germination in plane of symmetry, the equal valves showing the U-shaped cavity with U opening upwards with very unequal limbs. The longer micropylar limb lies nearest to the axis of the fruit, the shorter limb carries the subterminal chalaza on its inner angle. Limbs separated by a narrow condyle, hilum marginal at the end of the condyle indicated externally by a small aperture surrounded by radial ridges (cf. Chandler, 1925, pl. 1, fig. 6*a–c* and text-fig. 4). The hilar aperture is situated at about one-third of the length of the seed from its upper margin on the side sloping away from the fruit axis. Raphe canal wide lying within the condyle and extending for about one-quarter to one-half of the length of the seed. Micropyle terminal on the longer limb. Testa about 0·25 to 0·4 mm. thick its outer part (about 0·03 to 0·1 mm. thick) is a layer of large cells much inflated superficially when unabraded or not collapsed. These cells vary in diameter from 0·03 mm. to at least 0·15 mm.; they diverge from the chalazal region over the broad surfaces of the seed (Pl. 28, fig. 106). On the broad surfaces overlying the chalaza is a conspicuous thickening of much inflated large equiaxial cells like those in a similar position in *Eurya becktonensis* (p. 136). Inner part of testa compact formed of several layers of small rectangular cells about 0·016 to 0·025 mm. in diameter as in *Cleyera ? stigmosa* (p. 139). Seed cavity finely striate transversely. Length of seed about 4 mm.; breadth about 1·75 to 2 mm.

REMARKS AND AFFINITIES. The species is very abundant but perfect fruits are scarce owing to the decay and collapse of the lateral walls which allow the seeds to fall free. Examples of four good fruits are in V.42171. Isolated seeds are common (V.20035*a*, V.42172). These specimens were originally referred to the Araceae (Chandler, 1925) but at a later stage the testa structure appeared to connect them with *Cleyera ? stigmosa* then thought to belong to Myrtaceae on account of its U-shaped seed cavity (Chandler, 1961 : 80, 108, 335, pl. 8, figs. 8, 9; pl. 11, fig. 18; pl. 34, figs. 16–18). Recent work has however necessitated transferring both fossils to the section Taonabeae of the family Theaceae (Chandler, 1960 : 211) where alone the U-shaped cavity is combined with the distinctive testa structure described. No living genus exactly comparable with *Campylospermum* has been seen but there is a close general resemblance to species of *Ternstroemia* and *Anneslea* with a single ring of seeds. So far as the structure in these genera could be observed the testa appears to be smooth and without the large inflated cells described above. It must be borne in mind, however, that very little living material is available for dissection. Hence pending further information the name *Campylospermum* is retained.

Genus *CLEYERA* DC.

Cleyera ? stigmosa (Ludwig)

(Pl. 28, figs. 108–112)

1960. *Cleyera ? variabilis* (Chandler) Chandler, pp. 212, 213, 229, pl. 31, figs. 48–56 ; pl. 34, fig. 145. (see also for earlier references).
1960. *Eurya stigmosa* (Ludwig) Mai, p. 79, pl. 4, figs. 8–17.

Description. Several unmistakable seeds, much decayed or abraded and heavily pyritized show all the specific characters of this widely distributed Eocene species. Two seeds show remains of an outer thin striate coat which somewhat conceals the surface pits normally exposed ; it is formed of radially elongate cells, 0·013 to 0·016 mm. broad, which are often elongate-hexagonal in surface view. The descriptions of the species already published are applicable in every detail. There is the same U-shaped cavity and internal condyle, the walls show the same structure superficially, in section they are of the same thickness and are made up of the same small quadrangular cells. The tegmen is transversely striate, formed of equiaxial cells about 0·012 mm. in diameter. Diameter of three seeds respectively : 1·1 by 1·2 mm. ; 1·05 by 1·1 mm. ; 1·5 by 1·3 mm.

Remarks. Fourteen seeds (V.42176) and three figured ones. Also known from the Hengistbury and Barton Beds (Chandler, 1960), the Woolwich and Oldhaven Beds, the London Clay (Chandler, 1961) and the Bournemouth Beds, Highcliff Sands and freshwater Bracklesham Beds of Alum Bay (awaiting publication). Mai (1960) described this species from German localities identifying it with *Eurya stigmosa* (Ludwig) after comparison with original material.

Genus *ANNESLEA* Wall.

Anneslea ? costata n. sp.

(Pl. 29, figs. 113–115)

Diagnosis. Seed oboval to narrow-oboval in outline, much compressed having a median slightly curved ridge with rounded inner end over the condyle and a curved rounded ridge over the curved seed cavity beyond which is a marginal rim. Testa fine-celled. Length of seed, 2·2 mm. ; breadth, 1·3 to 2 mm.

Holotype. Brit. Mus.(N.H.), No. V.42177.

Description. *Seed :* Somewhat compressed, oboval to narrow-oboval in outline, curved so that the cavity is U-shaped, the limbs being separated by a condyle which is rounded at the inner end. At the base of the condyle is the marginal hilar aperture leading into the narrow median raphe canal within the condyle. Micropyle possibly represented by a small pit near the hilum at the end of one limb of the cavity. Externally a median slightly curved ridge with rounded inner end overlies the condyle and is separated by a narrow U-shaped furrow from a rounded U-shaped ridge which surrounds it and corresponds with the seed cavity. Outside again is a marginal rim (Pl. 29, fig. 113). Wall of condyle formed of coarse cells.

The external wall of the testa of fine cells the outlines of which are obscure. Seed cavity lined by cells transverse to its length, about 0·012 to 0·016 mm. broad. Length of seed, 2·2 mm.; breadth, 1·3 to 2 mm.; maximum breadth of condyle, 0·5 mm.

Remarks and affinities. Two seeds, one imperfect which was subsequently treated with nitric acid and dissected to show the condyle (V.42178). The character of the U-shaped cavity and raphe canal in condyle indicate the family Theaceae. The seed with its unpitted surface is unlike *Eurya*, *Adinandra* or *Cleyera*. The fine texture of the testa is more suggestive of *Anneslea* or *Ternstroemia*. Bearing in mind that few species of these genera are available for study and that other genera have not been seen at all the species is referred tentatively only to *Anneslea*. The rounded ridges of the surface appear to be distinctive so the name *Anneslea? costata* has been given. The genus *Anneslea* is Indomalayan. *Ternstroemia* belongs to Asia, Africa and South America.

Genus ***HORDWELLIA*** Chandler, 1960 : 228

Hordwellia crassisperma (Chandler)

1926. *Actinidia crassisperma* Chandler, p. 34, pl. 6, fig. 2; text-fig. 15.
1960. *Hordwellia crassisperma* (Chandler) Chandler, p. 229, pl. 34, figs. 140–144.
Hordwellia crassisperma (Chandler) Chandler (in press), pl. 17, figs. 8–61.

The species was referred to Theaceae by Chandler (1960) and has been redescribed and fully illustrated in a monograph on the Dorset Pipe-clay Series (now in press) where range of variation and geological distribution are shown. In addition to the holotype and seeds there illustrated, other seeds from Hordle are V.20069*a* and V.42179.

Family Thymeliaceae

Genus ?

An obovoid seed slightly imperfect at the pointed micropylar end, originally with crustaceous shining tegmen preserved, now represented by the white sandy cast and pulverized remains of the carbonaceous tegmen (V.42180) found in Bed 10 east of Long Mead End. Length of cast about 5 mm.; breadth, 2·75 mm. The tegmen was columnar in section with straight columns 0·008 to 0·01 mm. broad. A few broken but typical tegmen fragments of other seeds were also seen (V.42181) from Bed 10 east of Beckton Bunny. The surface was shining, formed of equiaxial cells flat or slightly convex superficially, some showing the tiny central lumen, the appearance varying greatly with the degree of abrasion. In some instances the whole surface appears minutely pitted. Most of the fragments show sub-spiral striation or furrowing caused by contraction and curling on drying. Although the material is too incomplete for more definite determination the characters seen indicate Thymeliaceae.

Family Lythraceae

Genus *MICRODIPTERA* Chandler, 1957 : 107

Microdiptera parva Chandler

(Pl. 29, figs. 116, 117)

1957. *Microdiptera parva* Chandler, p. 107, pl. 15, figs. 133–149 ; text-fig. 2.

Description. *Seed :* Subquandrangular in outline, much compressed. Raphe prominent median longitudinal on the ventral surface. Wings relatively thick, not concave on the ventral surface but breaking away from the seed body on both sides of the raphe. Dorsal surface with elliptical operculum or germination valve in the lower half of the seed, 0·5 by 0·35 mm. in diameter, ornamented with quadrangular cells in longitudinal rows about 0·03 mm. in diameter. Surface somewhat worn on the dorsal side over the wings, the external coat being abraded so that the underlying striate surface is exposed. The striae swerve around the operculum and across the wings. On the less abraded ventral surface there is a coat of variously oriented convex cells. Length of seed along axis, 0·9 mm. ; total breadth across body and wings, 1 mm.

Remarks. One seed (V.42182) has been compared with similar seeds from Bovey Tracey and Cliff End, Mudeford. It can be matched exactly in material from these deposits and has therefore been referred to *M. parva*.

Family Cornaceae

The family is represented at Hordle by six genera, four of which belong to the Mastixioideae (*Eomastixia, Mastixicarpum, Mastixia?* and Genus?) and two to the Cornoideae (*Cornus* and its sub-genus *Dunstania*). Four are extinct.

Section Mastixioideae

Genus *EOMASTIXIA* Chandler, 1926 : 37

Eomastixia rugosa (Zenker)

1960 *Eomastixia rugosa* (Zenker) : Chandler, p. 234.
Eomastixia rugosa (Zenker) : Chandler (in press), pl. 18, figs. 4–41 ; pl. 19, figs. 1–7.

For references see Chandler Dorset Pipe-clay Flora (in press) where the species is dealt with in detail and its variations and geological range are noted.

One of the most characteristic fossils of Bed 10, east of Beckton Bunny. In addition to the Hordle material recorded in the Dorset Pipe-clay monograph it is represented by the following specimens : V.20079*a* (Chandler, 1926, pl. 6, fig. 6*a*), V.20079*b* (Chandler, 1926, pl. 6, fig. 6*b*), V.20079*c* (Chandler, 1926, pl. 6, fig. 6*d*), V.20079*d* (Chandler, 1926, pl. 6, fig. 6*e*), V.20081 and V.42183 are three-loculed endocarps, V.42184 a four-loculed endocarp (rare), V.20080, V.20082, V.31792, V.42185 numerous endocarps. The original of Chandler, 1926, pl. 6, fig. 6*c* has decayed.

In Germany the species ranges from the Lower to the Middle Oligocene (Kirchheimer, 1957 : 260) whereas in Southern England, so far as present evidence goes, it is confined to the Eocene above the London Clay.

Genus *MASTIXICARPUM* Chandler, 1925 : 36

Mastixicarpum crassum Chandler

(Pl. 30, fig. 161)

1960 *Mastixicarpum crassum* Chandler : Chandler, p. 215.
Mastixicarpum crassum Chandler : Chandler (in press), pl. 19, figs. 14–23 ; pl. 20, figs. 1–4.

For references and range of variation of the species as well as its geological distribution see the Dorset Pipe-clay Flora (in press). Like *Eomastixia rugosa* it is among the commonest of the Hordle plants at Bed 10, east of Beckton Bunny and has also been found in an abraded state in rainwash from the contemporary stream channel west of Long Mead End (V.20077).

In addition to the Hordle material to which reference is made in that monograph and above there are the following specimens: V.20075–76, V.20078, V.31791, V.42186. An endocarp (V.42235) alleged to come from the Barton Clay of Barton was found in the Museum after the publication of the Bulletin on the Plant Remains of the Hengistbury and Barton Beds (Chandler, 1960). It is shown here for comparison and in order to complete the records (cf. Pl. 30, fig. 161). It has been fractured transversely and in spite of its poor condition shows the single locule with large longitudinal dorsal infold along the length of which splitting had started.

Genus *MASTIXIA* Blume

Mastixia ? glandulosa n. sp.

(Pl. 29, figs. 118–121)

1926. *Carpolithus* sp.2, Chandler, p. 44, pl. 7, fig. 12*a–d* ; text-fig. 28.

Diagnosis. Endocarp fusiform with a longitudinal external groove along which it splits, normally one-loculed, locule C-shaped in transverse section owing to an internal longitudinal infold which corresponds with the external groove. Wall riddled with innumerable resin ducts close to its outer surface. Length of endocarp, 7·75 to 13·5 mm. ; breadth about 3·5 to 5 mm.

Holotype. Brit. Mus. (N.H.), No. V.42187.

Description. *Fruit :* Not seen.

Endocarp : Fusiform sometimes more acutely pointed at one end than at the other, having a median external groove corresponding with a deep longitudinal infold which projects into the single locule causing it to be C-shaped in transverse section. Splitting tends to occur along the groove. External surface where best preserved showing a network of superficial fibres ; when somewhat abraded as is commonly the case, smooth with transverse striae. Walls thick with three regions as seen in transverse section : a thin outer region which tends to peel away on drying ; a

thick middle region riddled with innumerable elongate, oval, or irregularly angular lacunae now containing yellow solidified resin ; a thin inner region lining the locule. Locule transversely striate. No germination valve could be detected. Length of endocarp, 7·75 to 13·5 mm. ; breadth, 3·5 to 5 mm. Three typical endocarps showed the following measurements respectively : 1) Length, 10·5 mm. ; transverse diameter, 4 by 3·5 mm. 2) Length, 9·5 mm. ; transverse diameter, 5 mm. 3) Length, 7·75 mm. ; transverse diameter 3·5 mm.

Remarks and affinities. These peculiarly fragile endocarps are liable to shatter as they dry owing to the expansion of the resin in their walls and the contraction on drying of the carbonaceous tissues. Originally described as *Carpolithus* sp. 2 (Chandler, 1926 : 44) and believed to be two-loculed, the two-loculed effect is now known to be due to the close contact of the infold with the ventral wall of the locule caused by compression and partial collapse. At the same time the possibility of two-loculed specimens sometimes occurring cannot be wholly excluded. The single locule with longitudinal infold suggests alliance with *Mastixia* but the evidence of a germination valve is lacking probably because of the ready collapse of the resin riddled walls which makes a valve very difficult to detect. So far these abundant resin cavities have not been seen in *Mastixia* hence the ascription to the genus is regarded as doubtful but it must be borne in mind that only a few species of living *Mastixia* have been examined in section and that in ungerminated and unmacerated *Mastixia* it is almost impossible to detect the valve although longitudinal splitting down the infold is a fairly common feature.

Under the name *Retinomastixia schultei* (Kirchheimer, 1937 : 915, fig. 9) described an endocarp from the Middle Oligocene Brown Coal of Germany which he separated from *Mastixia* because of its numerous secreting cavities and the absence of an external longitudinal furrow associated with splitting. The absence of the furrow also distinguishes *Retinomastixia* from the Hordle fossils although this character can be obscured completely in compressed Hordle material. However *Retinomastixia* appears to differ also in the position of the resin layer which is nearer to the inner surface of the endocarp than in *Mastixia? glandulosa* so that there is a thicker woody layer outside it. *Retinomastixia* is, moreover, described as having a dorsal germination valve. In addition to the material figured from Hordle there are also V.42191 (three endocarps and a few fragments), V.20100, V.20102, V.42192 (various fragments with resin). V.20101 originally figured as *Carpolithus* sp. 2 is now in many fragments.

?Section Mastixioideae

Genus?

(Pl. 29, figs. 122–124)

1926. *Carpolithus* sp. 5, Chandler, p. 46, pl. 8, fig. 3*a–d*.

The median infold on each dorsal germination valve of this three-loculed fruit (V.20106*a*) suggests that the specimen may belong to Mastixioideae. Previously no suggestion as to its botanical position could be made. The subglobular shape is

one character which distinguishes it from any other species referred to Mastixioideae and the wide external grooving of the dorsal infolds on the valves is another. Also there appears to be no tendency to split along these infolds so far as can be seen.

Section Cornoideae

Genus ***CORNUS*** (Tourn.) L.

Cornus quadrilocularis Chandler

(Pl. 29, figs. 129–133)

1926. *Carpolithus* sp. 4, Chandler, p. 45, pl. 8, fig. 2*a*, *b*.
Cornus quadrilocularis Chandler (in press), pl. 20, figs. 23–26.

Description (emended). *Endocarp :* Subglobular with shallow apical depression but without central canal. Rounded or somewhat pointed at the base, four-loculed each locule having a large dorsal germination valve which separates from the apex downwards but remains attached at the base where it breaks irregularly. External surface finely pitted, walls thick, woody, of regular more or less equiaxial slightly sinuous cells. Locule lining of convex cells with finely digitate walls. Seeds solitary, the testa adhering closely to the locule wall, probably pendulous. Length of original endocarp (V.20106), 3·25 mm. ; transverse diameter, 3·5 mm. Length of V.42193, 3 mm. ; transverse diameter, 3·8 mm.

Seed : Represented only by collapsed remains of testa showing transversely aligned cells which give rise to transverse striae about 0·008 mm. apart.

Remarks. The fossil was originally described as *Carpolithus* sp. 4. The finding of a second endocarp made it possible to correct certain errors in the original description. Moreover these specimens are identical with endocarps from the Dorset Pipe-clay Series at Lake which show clearly that the seed was pendulous and confirm the observations recorded above based on Hordle material. A tendency to slight lateral compression is seen in V.42193 as in the Lake endocarps. For further remarks on relationship see Chandler (in press).

Sub-genus ***DUNSTANIA*** Reid & Chandler, 1933 : 459

Dunstania glandulosa (Chandler)

(Pl. 29, figs. 125–128)

1926. *Symplocoides glandulosa* Chandler, p. 41, pl. 7, fig. 5*a*, *b* ; text-fig. 26.
1926. *Carpolithes* sp. 3, Chandler, p. 45, pl. 8, fig. 1*a–e*.

Diagnosis. Pointed sub-fusiform endocarps about 5 to 9·5 mm. long, two- to four-loculed with small apical depression and ovoid secreting cavities in endocarp wall and to a less degree in septa.

Holotype. Brit. Mus. (N.H.), No. V.20090 (now much broken), Neotype V.42194.

Description. *Endocarp :* Pointed sub-fusiform, or pointed-ovoid, slightly compressed laterally in some instances, with a small truncation at the apex due to

an obconical or basin-shaped depression which may or may not have crenulate margins. Base usually sharply pointed. Locules two to four some of which may be abortive, they communicate with the apical depression. Each locule with a large dorsal germination valve extending almost throughout its length, with smooth sutures except at the base where they break irregularly from the lower part of the endocarp wall. Wall thick formed of cells with sinuous outlines. In section three regions can be distinguished : a thin compact dark outer region, a thick middle region more spongy in texture with numerous ovoid secreting cavities, a thin compact inner layer. Secreting cavities, diameter about 0·1 to 1 mm. with smooth shining walls lined by cells with sinuous outlines often about 0·05 mm. in diameter. The cavities occur in the septa but to a much less extent than in the outer walls of the endocarp, usually smaller in the septa. Locule lining smooth, transversely striate, with sinuous-walled cells. Dimensions of several endocarps : 1) Length, 9·5 mm. ; breadth, 4·25 mm. 2) Length, 8·75 mm. ; breadth, 3·5 mm. 3) Length, 5·5 mm. ; breadth, 4 mm. 4) Length, 9 mm. ; breadth, 8 mm. 5) Length, 7 mm. ; breadth, 2·25 by 3·25 mm. Thickness of dorsal wall where measured, 1·75 to 2·5 mm.

Seed : Solitary, represented only by remains of testa adhering to the locule (N.B. the body described as a seed in 1926, p. 45 was undoubtedly a locule cast). Testa structure obscured owing to crumpling.

Remarks. When originally described under the names *Symplocoides glandulosa* and *Carpolithes* sp. 3 the structure of these fruits was only partly understood and was therefore wrongly interpreted. The truncate end was then regarded as the base. *Carpolithes* sp. 3 is a well developed endocarp in which the septa has been accidentally pierced so that the three locules have a false appearance of being in communication with one another. Three additional endocarps without septal break were, however, referred tentatively to the same species. In the holotype the base was broken and abraded so that three locule cavities were exposed simulating the apex of an endocarp like *Symplocos*. The examination of hundreds of pyritized fruits of *Dunstania multilocularis* from the London Clay illuminated the structure of the smaller carbonaceous Hordle specimens and it became clear that they and *Dunstania* were closely related. The Hordle endocarps are much smaller than either of the London Clay species, also relatively longer and narrower with more acutely pointed base while so far no more than four locules have been seen. Reid & Chandler referred *Dunstania* to Cornaceae for reasons given (1933 : 461). Kirchheimer has since confirmed the relationship noting that in the sub-genus *Bothrocaryum* of *Cornus* there is a deep depression at the apex of the endocarp and that in the sub-genus *Macrocarpum* and in *Cornus Volkensii* (sub-genus *Afrocrania*) there are secreting cavities. He stresses the fact that the occurrence of more than two locules is not uncommon in living *Cornus* (Kirchheimer, 1948 : 85 ; 1957 : 443). The fossils combine the presence of an apical pit as in *Bothrocaryum* with that of secreting cavities as in *Macrocarpum*. In the latter sub-genus only, a small apical pit sometimes occurs e.g. in *Cornus mas*. The fossils may therefore represent a distinct sub-genus of *Cornus* for which the name *Dunstania* may conveniently be retained at least for the present. The specific name *D. glandulosa* is dictated by

its earlier use. In addition to the specimens figured or mentioned above there are the following three-loculed endocarps : V.20103–04*c* (V.20103 being figured Chandler, 1926, pl. 8, fig. 1*a–e*), V.20104*d* a two-loculed endocarp, V.20104*e* a four-loculed endocarp and V.42196 several endocarps, some abraded and some sectioned.

Family Ericaceae

Section Andromedeae

Genus? sp. 2

(Pl. 30, fig. 138)

1926. Ericaceae Genus ? sp. 2, Chandler, p. 38, pl. 6, fig. 8*a–c*.

Description. *Fruit :* A superior loculicidal capsule, subcircular in outline, somewhat depressed from apex to base, not stipitate but seated upon a persistent perianth disc equal to the fruit in diameter. Surface of fruit with shallow longitudinal concavities over the septa and slight rounded ridges between these concavities overlying the locules. Apex slightly incurved but having a prominent broad circular style base. External surface finely but irregularly pitted and rugose, formed of equiaxial cells. Carpel wall thick. Placentation axile from large basal placentas in the inner angles of the locules. Seeds numerous sunk partially in shallow depressions of the locule wall. Transverse diameter of fruit originally described (now decayed), 1 mm. ; height, 0·9 mm. Transverse diameter of a larger fruit, 1·5 mm. ; height, 0·7 mm. Thickness of perianth disc about 0·1 mm.

Seed : Rounded-oblong, anatropous, ornamented with a raised network of elongate longitudinally aligned meshes crossed by fine transverse striae, the meshes following the curvature of the seed at the rounded distal end. Length of seed, 0·33 mm. ; breadth, 0·16 mm.

Remarks. The seeds were beautifully shown in the first described specimen, preserved in shining pyrites which displayed the reticulate pattern very clearly. V.42198 has not dehisced but shows well the external characters of the fruit. V.42199 originally measuring 1 by 0·75 mm. broke longitudinally later and showed three seeds in one locule and their mode of attachment. Reference to the section Andromedeae of Ericaceae was suggested in 1926 and no closer suggestion as to affinity can yet be made. The specimens although somewhat resembling *Epacridicarpum mudense* are distinguished by the depressed form, persistent perianth and several-seeded locules.

Family Epacridaceae

Genus ***EPACRIDICARPUM*** Chandler, 1960 : 214

Epacridicarpum headonense Chandler

(Pl. 29, figs. 134–137)

1926. Andromedeae Genus ? sp. 1, Chandler, p. 37, pl. 6, fig. 7*a*, *b*.
1960. *Epacridicarpum headonense* Chandler, p. 234, pl. 34, figs. 146, 147,

Description. *Fruit :* A sub-hemispherical or oblate-sphaeroidal five-loculed loculicidal capsule. Upper surface somewhat flattened, lower convex, sometimes

slightly stipitate. Surface ornamented with unequal irregular pits. Walls thick the outer layers about 0·05 to 0·15 mm. thick formed of several layers of rounded equiaxial cells many being about 0·025 mm. in diameter; inner layers somewhat thinner of narrow elongate longitudinally aligned cells closely compacted. Locule lining of elongate convex cells which diverge obliquely from subapical axile placentae. These cells vary considerably in length and breadth, many are 0·009 mm. broad and 0·05 to 0·1 mm. long. Length of fruit, 0·55 to 1·25 mm.; diameter 1 to 1·75 mm. (Note in Chandler, 1960, p. 234 the diameter of the species was incorrectly given).

Seed: Pendulous, solitary. Testa too crumpled to show cell structure.

Remarks and affinities. The capsule figured by Chandler (1926, pl. 6, fig. 7*b*) is now represented by two only of its valves. V.20083*a* which was figured by Chandler (1926, pl. 6, fig. 7*a*) and again in this present work and V.20084*a*. In addition there is the beautifully preserved fruit now fractured longitudinally (V.42197, see Pl. 29, figs. 136, 137). V.20084*b* shows two valves of another fruit and V.20084*c*, *d* are valves of doubtful identity. The characters are those of Ericales. Loculicidal dehiscence and slightly sunk apex seen in Clethraceae, Pyrolaceae, Ericaceae and Epacridaceae. Clethraceae are three-loculed. Pyrolaceae and Ericaceae of this type have much larger capsules with thin walls and usually with numerous seeds. The Stypheliae of the family Epacridaceae appear most to resemble the fossil. The locules are single-seeded. Although the dry multilocular "stone" does not appear to dehisce there can be little doubt that maceration prior to germination causes splitting for the release of the seeds. Although the Epacridaceae are chiefly Australian they also grow in India, South America and the sandy heaths of the Malay Peninsula. The fossil species also occurs in the Lower Bartonian and the Highcliff Sands at Cliff End near Mudeford.

Family Ebenaceae

Genus ***DIOSPYROS*** Linnaeus

Diospyros headonensis nom. nov.

1926. *Diospyros antiqua* Chandler, p. 38, pl. 7, fig. 2; text-figs. 21, 22.
Diospyros headonensis Chandler: Chandler (in press), pl. 20, figs. 28, 29; pl. 21, figs. 1–5.

Remarks. For additional details see Chandler (in press) where a specimen from the Lower Bagshot, Lake, Dorset, with a young fruit was described and illustrated in addition to further Hordle material. Respective registered numbers are also shown there. It may now be added that the calyx is occasionally five-partite (one of the calyces in V.42200) and the range of variation of size is greater than hitherto recorded (cf. V.42201). Several small specimens from Hordle, probably immature, are only about 2 mm. long as against the normal 4·5 to 6·5 mm. In a few cases the sepals have incurled edges giving a deceptive narrow-pointed form. V.20086*d* shows detached sepals.

The name *Diospyros antiqua* is pre-occupied by Watelet (1866 : 207) for a leaf impression from the Eocene of Belleu, Paris Basin, France and the Hordle fruits have therefore been given the new name *Diospyros headonensis*.

Family Symplocaceae

Genus ***SYMPLOCOS*** Jacquin

Symplocos headonensis Chandler

(Pl. 30, figs. 139, 140)

1926. *Symplocos headonensis* Chandler, p. 40, pl. 7, fig. 3*a–c* ; text-fig. 24.
1957 *Symplocos headonensis* Chandler : Chandler, p. 117, pl. 17, figs. 187, 188.
1960 *? Symplocos headonensis* Chandler : Chandler, p. 215, pl. 31, figs. 58, 59.
Symplocos headonensis Chandler : Chandler (in press), pl. 21, figs. 19, ? 20.

Diagnosis. Endocarp truncate subglobular, ovoid or urceolate, three-to-five-loculed ; external surface smooth formed of fine equiaxial cells. Length, 5 to 6 mm. ; breadth, 3·5 to 5·5 mm.

Neotype. Brit. Mus. (N.H.), No. V.42202.

Remarks. The smooth external surface of the endocarp is formed of equiaxial cells 0·016 to 0·025 mm. in diameter and the external carpel wall may be as much as 0·4 to 0·45 mm. thick at the middle. For relationship to living species see Chandler (1926 : 40). The originals of Chandler, 1926, pl. 7, fig. 3*a*, *c* are now decayed while that of fig. 3*b* (V.20087) is in poor condition. Hence the selection of a neotype from fresh material. Numerous endocarps are still extant (V.42204).

Symplocos sp.

1926. *Symplocos* sp. 2, Chandler, p. 40, pl. 7, fig. 4 ; text-fig. 25.
Symplocos sp. Chandler (in press), pl. 21, figs. 21, 22.

Although no further material has been found at Hordle, a specimen is known from the Dorset Pipe-clay Series. The small apical depression and smooth external surface appear to be constant features but the evidence does not seem sufficiently distinctive for specific diagnosis. The original endocarp from Hordle (V.20088) is now much broken but shows remains of two seeds extracted from it (V.20089).

Family Styracaceae

Genus ***STYRAX*** (Tourn.) L.

Styrax elegans Chandler

1926. *Styrax elegans* Chandler, p. 41, pl. 7, fig. 6*a–f*.
Styrax elegans Chandler : Chandler (in press), pl. 21, figs. 24–28.

The holotype (V.20091) was illustrated by Chandler (1926, pl. 7, fig. 6*a–c* ; in press, pl. 21, figs. 26, 27). The specimen represented in 1926, pl. 7, fig. 6*d* is now decayed. V.20092 was illustrated in 1926 in pl. 7, fig. 6*e* to show the internal nerves of the testa. Broken endocarps somewhat decayed are preserved in V.20093–94, V.42205–06. The latter shows a seed with one concave surface owing to pressure of a second seed in the fruit during growth. The discovery of the species in the Dorset Pipe-clay Series at Lake may be noted.

Family Oleaceae

Genus ***OLEA*** (Tourn.) L.

Olea headonensis n. sp.

(Pl. 30, figs. 141–143)

1926. Oleaceae Genus ?, Chandler, p. 42, pl. 7, fig. 7 ; text-fig. 27*a–c*.

Diagnosis. Endocarp subovoid but with slight bisymmetry, two-loculed, one locule being abortive, dehiscing loculicidally. External surface smooth or slightly rugose. Length of endocarp, 3·25 to 5·5 mm. ; breadth in plane of symmetry, 2·25 to 4·25 mm. ; thickness, 2 to 3·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.42207.

Description. *Endocarp :* Woody, subovoid but slightly bisymmetric, angled at the apical end in the plane of symmetry, dehiscing into equal valves loculicidally, two-loculed, one locule being abortive, having one developed pendulous seed in the mature locule. Attachment scar large, basal, leading into a short oblique fibro-vascular canal (Pl. 30, figs. 142, 143 and Chandler, 1926, text-fig. 27*b*) which lies in the plane of dehiscence. External surface smooth, or only slightly rugose, usually without fibres although occasional fibre impressions are seen. Locule lining transversely striate and puckered, shining, with underlying transverse fibres. Smooth suture for dehiscence showing fine fibres variously aligned. Dimensions of four endocarps : 1) Length, 4·75 mm. ; breadth, 3·75 mm. ; thickness, 3 mm. ; thickness of wall, 0·8 mm. 2) Length, 3·75 mm. ; breadth, 2·75 mm. ; thickness, 2·5 mm. 3) Length, 5·5 mm. ; breadth, 4·25 mm. ; thickness, 3·5 mm. 4) Length, 3·25 mm. ; breadth, 2·25 mm. ; thickness, 2 mm.

Seed : Much crumpled as preserved. Testa formed of double-walled rectangular cells frequently measuring 0·1 by 0·05 mm. The seed shows remains of dark-coloured broad flat fibre bands (now much shattered).

Remarks and affinities. Perfect endocarps are V.42208, V.42210. There are also an endocarp split loculicidally (V.42211) and numerous fragments (V.42212). V.42209 was figured by Chandler, (1926, pl. 7, fig. 7 ; text-fig. 27*a–c*). Form, locules, dehiscence and funicle, also the structure of endocarp and seed suggest Olacineae, family Oleaceae. No Recent *Olea* has been seen without external fibres associated with marked rugosities. Their absence in the fossil is no doubt due to abrasion as in some species of *Olea* they are readlly removable and traces of them have been seen in *O. headonensis*. Endocarps similiar in form and size are found in the living genus *Olea* which today occurs in the Mediterranean, South Africa, the East Indies, Polynesia and Australia.

Family Boraginaceae

Genus ***OMPHALODES*** Tourn. ex Moench.

Omphalodes platycarpa Chandler

1926. *Omphalodes platycarpa* Chandler, p. 42, pl. 7, fig. 8*a*, *b*.

Holotype. Brit. Mus. (N.H.), No. V.20095.

Remarks. The original of Chandler, 1926, pl. 7, fig. 8*b* is decayed. V.20095*a*

is a carpel partially dissected to show the inner surface (figured Chandler, 1926, pl. 7, fig. 8*a*). Additional material is needed to confirm the determination.

Family Acanthaceae

Genus *ACANTHUS* Linnaeus

? Acanthus sp.

(Pl. 30, figs. 144, 145)

Description. *Seed:* Much compressed, more or less quadrangular in outline, the angles being somewhat rounded. Two of the adjacent sides of the quadrangle are of approximately equal length and are appreciably shorter than the other two. A large elliptical marginal scar is seen at the middle of one of the shorter sides, this side being concave. The other short side is slightly convex. Unfortunately the angle where the two longer sides meet is broken. One broad surface of the seed is more or less flat, the other is concave near the hilar scar but has a long narrow curved facet extending from the angle where the two shorter sides meet to that where the two longer sides meet. It is probably caused by pressure of an adjacent seed or by contact with the fruit wall during growth. Surface ornamented all over with close-set puckerings many of which appear as shining black convex areas with toothed outlines. These areas may be circular, elliptical or irregular and are about 0·05 to 0·1 mm. in diameter. In general the surface is rough owing to fine equiaxial pits but a few of the black convex puckerings do not show the pitted tissue seen elsewhere. Along a line between the broken angle of the seed and the hilum the puckerings become somewhat elongate. Maximum diameter of seed, 4 mm.; diameter at right angles to this, 3 mm.; thickness at right angles to the broad surfaces, 1 to 1·5 mm.

Remarks. The form and puckered surface suggest Acanthaceae. The fossil most resembles a few seeds in the Reid Collection found as accidental impurities in a packet of *Acacia catechu* from an Indian Collection of seeds presented by the Keeper of Kew Herbarium. These were provisionally identified as *Acanthus* sp.

Family Caprifoliaceae

Genus *SAMBUCUS* (Tourn.) L.

Sambucus parvulus Chandler

1926. *Sambucus parvulus* Chandler, p. 43, pl. 7, fig. 9*a–c*.
Sambucus parvulus Chandler: Chandler (in press), pl. 23, figs. 1–10.

Diagnosis. Seed 1·1 to 1·5 mm. long. Surface with about six to ten sinuous transverse ridges with interspaces as broad as or broader than the ridges.

Holotype. Brit. Mus. (N.H.), No. V.20096.

Description. The original description has been emended in minor respects and now stands as follows: Seed exceptionally small and thin, obovate or elongate-obovate, compressed, often concavo-convex, anatropous, micropyle and hilum

terminal on the ventral face ; raphe ventral median longitudinal marked externally by an obscure longitudinal angle. Surface ornamented with from six to ten sinuous, sometimes interrupted transverse ridges with interspaces as broad as or broader than the ridges. Testa formed externally of equiaxial cells about 0·012 to 0·016 mm. in diameter. Length of seed, 1·1 to 1·5 mm. ; breadth, 0·6 to 1 mm.

Remarks. Although the majority of the seeds were found in Bed 10 east of Beckton Bunny, a few occurred in Bed 10 below Hordle House. The well represented seeds are readily distinguished by their small size and delicate appearance from any living *Sambucus* seed. The wide spacing and relative coarseness and fewness of the transverse ridges is a distinctive feature. A single seed was found in the Dorset Pipe-clay Series at Lake. Although primarily a temperate genus of the Northern Hemisphere it also occurs in the East Indies, Australia, Tasmania and South America. In addition to specimens figured there are numerous seeds (V.42214).

Family Cucurbitaceae

Genus ***CUCURBITOSPERMUM*** Chesters, 1957 : 56

Cucurbitospermum reidii n. sp.

(Pl. 30, fig. 146)

1926. Cucurbitaceae Genus ?, Chandler, p. 43, pl. 7, fig. 10*a*, *b*.

Diagnosis. Seed subtriangular in outline, elongate and narrow at the base, truncate at the apex, with a raised somewhat rugose median area pointed at both ends and a flat smooth marginal area which disappears at the apex, ends abruptly at the base and corresponds with an internal suture. Length of valve, 8·5 mm. ; breadth, 4·5 mm.

Holotype. Brit. Mus. (N.H.), No. V.20098.

Description. *Seed :* Subtriangular in outline, elongate and narrow at the base, truncate at the apex, flattened, with a raised ornamental median area which is pointed at both ends. The ornamentation is of elongate rugosites aligned more or less at right angles to the margin of the raised area. There is a broad smooth flat marginal rim which does not extend around base or apex ; at the apex its termination causes the truncate appearance. At the base also it ends abruptly. Hence at both ends of the seed the pointed extremities of the raised median area project beyond the rim. An internal hollow corresponds to the raised area and a marginal internal suture to the external smooth rim (Chandler, 1926, pl. 7, fig. 10*a*, *b*). The broad suture indicates that the specimen is one valve of a bisymmetric seed which has split marginally in the plane of symmetry, the other valve is missing. Length of valve, 8·5 mm. ; breadth, 4·5 mm.

Remarks and affinities. A single seed from Bed 10 below Hordle House. Both apex and base of this seed are very slightly imperfect, and the specimen is abraded so that the micropyle and raphe are obscure but form and structure indicate Cucurbitaceae. The seed is of a distinctive form which has not been matched precisely among the living genera that could be examined. Hence the reference to the form-

genus *Cucurbitospermum*. A similar raised median area occurs in *Sicydium* Schlechtd. a tropical American genus, otherwise not closely similar, and in *Lagenaria* Ser. the median area is of the same shape but is not conspicuously raised and rugose as in the fossil.

Family ?

Genus ***RHAMNOSPERMUM*** Chandler, 1925 : 30

Rhamnospermum bilobatum Chandler

1960. *Rhamnospermum bilobatum* Chandler : Chandler, pp. 216, 236, pl. 32, figs. 60, 61 ; pl. 35, figs. 155, 156.
Rhamnospermum bilobatum Chandler : Chandler (in press), pl. 23, figs. 18–38, pl. 24, figs. 1–9. See also for earlier references.

The species occurs abundantly at Hordle in Bed 10, east of Beckton Bunny (V.42216) and below Hordle House (V.42215) and is rare in Bed 29 (V.20047*a*). In addition to the above there are V.20064*a* (Chandler, 1926, pl. 5, fig. 1*a*), V.20064*b* (Chandler, 1926, pl. 5, fig. 1*b* ; Chandler (in press), pl. 23, fig. 18) and V.20064*c* (Chandler, 1926, pl. 5, fig. 1*c* ; Chandler (in press) pl. 23, fig. 19).

For range of species and its variations, also remarks on affinities see Chandler, Flora of the Dorset Pipe-clay Series (in press).

Carpolithus fibrosus n. sp.

1926. *Carpolithus* sp. 7, Chandler, p. 46, pl. 8, fig. 5*a*, *b* ; text-fig. 30.

Diagnosis. Fruit syncarpous, two to six-carpelled, seated on a low conical receptacle with free persistent sepals, obovoid or ovoid, splitting loculicidally. Endocarp thick and woody formed of stout longitudinal fibres. Length of fruit, 4·25 to 6 mm. ; breadth, 3·25 to 4·5 mm. Seeds linear, anatropous, about 2 to 3 mm. long with hyaline integuments.

Holotype. Brit. Mus. (N.H.), No. V.20108.

Description. *Fruit :* Syncarpous, woody, ovoid or obovoid, superior, attached to a low conical receptacle which bears at its margin a small calyx of persistent free sepals. (Both calyx and receptacle often broken away as in holotype, see Chandler, 1926, pl. 8, fig. 5*a*.) Two to six-carpelled, splitting loculicidally especially at the apex but the smooth surfaces of the septa rarely seen except towards the base. Interior of fruit occupied almost completely by longitudinally aligned agglomerated woody fibres (endocarp?) among which slender pendulous seeds lie in elongate narrow cavities. Whether there is more than one seed in a cavity has not been determined. External surface rough, exocarp about 0·2 mm. thick formed of shining, longitudinally aligned cells of irregular shape about 0·03 mm. in diameter. There are a few embedded longitudinal fibres in this coat, one such delimiting the margin of each carpel. Internally each carpel has a conspicuous median longitudinal ridge formed of woody fibres especially noticeable at the apex where the fibres are somewhat contorted and appear to form placentas. Length of fruit, 4·25 to 6 mm. ; diameter, 3·25 to 4·5 mm.

Seed: Linear, compressed or inflated, anatropous. Hilar surface flat, oval; chalaza a black oval thickened scar 0·35 by 0·25 mm. in diameter at the opposite end to the hilum situated therefore at the end of the seed near the base of the locule. Integuments thin. The coat usually preserved (tegmen?) is hyaline formed of longitudinally elongate parallel-sided cells 0·012 mm. broad, square or facetted at the ends. Outside this a rough coat is sometimes seen with similiar cells and there is sometimes a coat of equiaxial cells about 0·01 to 0·016 mm. in diameter (Chandler, 1926, text-fig. 30*a*) which may be part of the testa, or may belong to the locule wall. Sometimes the hyaline integument bears internal impressions of large rectangular cells 0·016 to 0·025 mm. in diameter. Transversely elongate cells arranged in longitudinal rows have also been seen internally (Chandler, 1926, text-fig. 30*b*). Length of seed, 2 to 3 mm.

Remarks. Fruits common but often imperfect owing to the tendency to break longitudinally again and again. V.20109*c* is an imperfect fruit with remains of receptacle still attached. V.20109 and V.20109*a* are longitudinally fractured fruits. V.42219 has the pericarp abraded so that the fibre mass is exposed with some seeds showing through it and V.42220 is a similar specimen. Woody interior is well shown in V.42218. In V.42217 half of a longitudinally fractured fruit shows seeds one with a black oval chalazal scar. Other specimens or segments of fruits are V.20109, V.42221–23. The original of Chandler, 1926, pl. 8, fig. 5*b* is decayed. The botanical position has not yet been determined but this readily recognizable species appears to be worthy of a specific name especially as it has now been found also in the Bournemouth Beds. There is a certain resemblance between this and the specimen from the London Clay called *Trochodendron? pauciseminum* (Reid & Chandler, 1933 : 155, pl. 3, figs. 29–33) but that was thought to be septicidal. If further London Clay material could be found a comparison should be made, observations checked and the relationship reconsidered. The size is similar as are the coats of the slender seed.

Carpolithus apocyniformis n. sp.

(Pl. 30, figs. 147, 148)

Diagnosis. Detached valves of a loculicidal multilocular capsule, narrow-ovate in outline, slightly convex on the external surface which is finely furrowed and longitudinally striate, slightly concave on the inner surface which has a median longitudinal septal ridge throughout. Length of valves about 4·25 to 6·5 mm.; breadth about 1·5 to 3 mm.

Holotype. Brit. Mus. (N.H.), No. V.42224.

Description. *Valve:* Apparently part of a multilocular capsule now always detached, narrow-ovate in outline, pointed or rounded at the distal end (usually broken), truncate at the proximal end where broken from the fruit. External surface slightly convex, black and rather rough owing to short irregular longitudinal furrows, cell structure obscure but some cells with black shining contents can be seen. Inner surface slightly concave, smooth finely striate longitudinally with low median longitudinal ridge throughout its length which appears to be the remains of a

septum. Beneath the epicarp is a light brown layer formed of cells about 0·012 mm. long, 0·016 mm. broad. The valve is solid as seen in transverse section. Length of valve about 4·25 to 6·5 mm.; breadth, 1·5 to 3 mm.

Remarks. These specimens are not uncommon and two have occasionally been seen adhering by their lateral margins. The solid section excludes all possibility that they are seeds in spite of a superficial resemblance to seeds of Apocynaceae. The adherent specimens, the constant presence of the median ridge and the transverse break at one end suggests that they are detached valves of a dehisced capsule but no suggestion as to relationship can at present be made. The distal end of the holotype is imperfect but the form of the unbroken valve tip has been seen on a broken specimen with other imperfect valves in V.42226. There is also an almost perfect tip in V.42227 and in the figured specimen V.42225 (somewhat pyritized). Further material will be described in due course when the British Museum monograph on the Bournemouth Beds is published.

Carpolithus sp.

(Pl. 30, figs. 149–153)

1926. *Carpolithus* sp. 8, Chandler, p. 47; text-fig. 31.

Description. *Ovary:* Superior, conical with flat pentagonal basal perianth disc showing remains of peduncle. Carpels normally three (rarely four), syncarpous with three short apical styles and three locules. Epicarp thin, loosely fitting, shining, formed of square or hexagonal cells, carpel wall within spongy in transverse section. Locule lining of transversely elongate cells arranged in vertical rows, longitudinally puckered the puckerings sometimes branching and anastomozing. Seeds not seen. Length of ovary about 3 mm.; breadth, 1·75 to 2·5 mm.

Remarks. These specimens seem to be immature fruits or ovaries rather than ripe fruits. They are often collapsed and distorted. The relationship has not been discovered. The following are three-loculed: V.20110, V.20110*a* (Pl. 30, fig. 151), V.20110*b* (Pl. 30, fig. 150, shows perianth disc clearly), V.20110*c* (Pl. 30, fig. 149), V.20110*d* (Pl. 30, fig. 153). V.20110*e* (Pl. 30, fig. 152) is a rare four-loculed specimen. Numerous fruits are registered under V.42228.

? *Carpolithus gardneri* Chandler

1926. *Orites* sp. Chandler, p. 47, pl. 8, fig. 6.

V.15520 the finest specimen was originally described as *Orites* sp. There are in addition nineteen other specimens V.421*a–s*. All are now much decayed. Some are merely detached fruits. One internal cast shows fine transverse striations. As noted in 1926 there is a resemblance to a species from the Reading Beds now described as *Carpolithus gardneri* (Chandler, 1961 : 85, pl. 9, figs. 1–5; text-fig. 4) both in the branching racemose habit and structure of the pods but *C. gardneri* appears to have more slender fruits and it is doubtful whether the two are identical or whether there is sufficient evidence to connect the Hordle species with *Orites*

in spite of a similarity of habit. The specimens are preserved in a sandy whitish-grey clay. The locality in Hordle cliff is almost certainly Bed 10 as the matrix agrees with that of " *Nelumbium buchi* Ett. " (Chandler, 1926 : 48).

Carpolithus sp.

(Pl. 30, figs. 154–156)

1926. *Carpolithus* sp. 1, Chandler, p. 44, pl. 7, fig. 11*a*, *b*.

This six-lobed solid organ is still unidentified. Each of the six lobes has two transverse constrictions and new material shows remains of a shining epidermis of equiaxial cells. The comparable Recent object found as described in 1926 as an impurity in a packet of seed of *Zelkova Keaki* from the Yokohama Nursery Company is figured in Pl. 30, fig. 157. Length of specimens, 3 to 6 mm. ; transverse diameter, 1 to 3·5 mm. V.42229 (see Pl. 30, figs. 155, 156) and V.42230–31 are extant but the specimen figured in 1926 is now decayed.

Carpolithus sp.

(Pl. 30, fig. 158)

Description. *Seed :* Small, bisymmetric, curved, reniform represented by one valve only. Hilum near the middle of the concave margin. Other organs obscure but as one limb is narrower than the other the micropyle probably lay at its tip. Hilum a conspicuous aperture leading directly to the seed cavity. As seen in section the wall of the chalazal limb somewhat overlaps the wall of the micropylar limb and is recurved lying closely upon itself and passing into the tegmen. Testa surface of equiaxial cells superficially which diverge from the hilum, are about 0·012 to 0·016 mm. in diameter, and are so thick-walled that the small cavity appears as a central pit or depression. In section the testa is columnar and about 0·05 mm. thick. Lining of testa obscure but apparently formed of digitate cells. Maximum diameter of seed about 1·15 mm. ; diameter through the hilum at right angles to this about 0·9 mm. The seed has split in the plane of symmetry as for germination. Its systematic position is not known.

Carpolithus sp.

(Pl. 30, fig. 159)

Description. *Fruit :* Subglobular, syncarpous, four-loculed, locules unequally developed, opening by dorsal valves which gape at the apex and sides but break irregularly below. No central canal seen but there appears to be a thickened scar on the median line of the ventral wall of each locule at about one-quarter of the length from the apex which may mark the attachment of a solitary seed. Walls woody, septa formed internally of equiaxial cells about 0·016 mm. in diameter, but superficially of elongate cells parallel with the surfaces, the length of these cells being about 0·05 mm. and their breadth about 0·008 mm. Cells of the locules elongate,

about 0·007 mm. broad and of variable length, frequently 0·05 mm. These cells are arranged in groups on the whole obliquely aligned and diverging from the sub-apical placenta (?) and below this point upwards from the median ventral line of the locule.

Seed : Agreeing with the locule in shape, with large thickened basal chalaza ; testa of longitudinally elongate cells, 0·01 mm. broad.

Remarks. A single fruit of unknown affinity now dissected.

Gall or Tuber?

(Pl. 30, fig. 160)

Description. A subglobular hollow body, burst at one end (now fractured into two pieces) with scaly surface having irregular rugosities separated by deep cracks sometimes arranged concentrically around a more or less smooth area. There are a few small circular apertures seen especially on the smooth areas. Wall finely columnar in section and about 0·05 mm. thick. Within are remains of a yellow semi-translucent skin of chitinous appearance in which no cell walls can be seen. Dimensions, 2·5 by 2 mm.

Remarks. A gall or tuber? which closely resembles similar organisms from the Dorset Pipe-clay Series (Chandler, (in press), pl. 27, figs. 26–29) and from the London Clay (Chandler, 1961 : 324, pl. 32, fig. 33). Identity not determined.

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EXPLANATION OF PLATES

Unless specifically stated otherwise all specimens figured are from Hordle.

PLATE 24

Salvinia mildeana Goeppert

FIG. 1. Part of the leaf (figured Chandler, 1925, pl. 1, fig. 1*a*) to show arrangement of papillae between secondary nerves. ×4. (V.36344.)

Acrostichum lanzaeanum (Visiani)

FIG. 2. Pinnule fragment. ×2. (V.42058.) Alleged to come from Barton clay, Barton. For comparison with Hordle material previously figured.

Potamogeton pygmaeus Chandler

FIGS. 3, 4. Abraded endocarps. In fig. 3 keel tip broken. ×15. (V.42054–55.) *Limnocarpus* Band, Colwell Bay, Isle of Wight.

FIGS. 5, 6. Endocarps from Hordle for comparison. Fig. 5 shows gaping keel, fig. 6 the style. ×15. Decayed.

Limnocarpus forbesi (Heer)

FIG. 7. Endocarp, side, with style and lateral foramen; slightly imperfect below. ×15. (V.42064.) *Limnocarpus* Band, Colwell Bay, Isle of Wight.

FIG. 8. Another, similar aspect, tip of keel broken. ×15. (V.42062.) Lower Headon, bomb crater, Downton, Hordle.

FIG. 9. Endocarp, ventral, with style and stalk. ×15. (V.42065.)

FIG. 10. Endocarp, dorsilateral, tilted to show tip of keel. ×15. (V.42066.)

FIG. 11. Endocarp, dorsilateral, sand filled cavity exposed by loss of keel. ×15. (V.42061.)

Figs. 9–11 from *Limnocarpus* Band, Colwell Bay, Isle of Wight.

Stratiotes hantonensis Chandler

FIGS. 12, 13. Inner surface of two valves from sigmoidal seeds showing short raphe. ×6·5. (V.42084, V.42086.)

FIG. 14. Seed somewhat dorsiventrally crushed. ×6·5. (V.42085.)

FIGS. 15, 16. Two seeds showing sigmoidal and hooked forms. ×6·5. (V.42083, V.42086*a*.)

Stratiotes headonensis Chandler

FIG. 17. Typical seed for comparison with the above. ×6. (V.20031*a*.)

Caricoidea minima (Chandler)

FIG. 18. Holotype. Endocarp tilted to show basal aperture and a longitudinal rib. ×15. (V.20033.)

FIG. 19. Fruit, side. ×15. (V.42087.)

FIG. 20. Another endocarp, side. ×15. (Decayed.)

FIG. 21. Larger fruit. ×15. (V.42088.)

Caricoidea obscura Chandler

FIG. 22. Fruit, side. ×15. (V.42092.)

FIGS. 23, 24. Two endocarps. ×15. (V.42093–94.)

Scleria hordwellensis n. sp.

FIG. 25. Holotype. Fruit, apex, calyx can be seen projecting around the circumference. ×6·5. (V.42096.)

FIG. 26. Same, side, at the base is seen thick calyx with transverse puckerings, (*s*) style. ×15.

CYPERACEAE, Genus ?

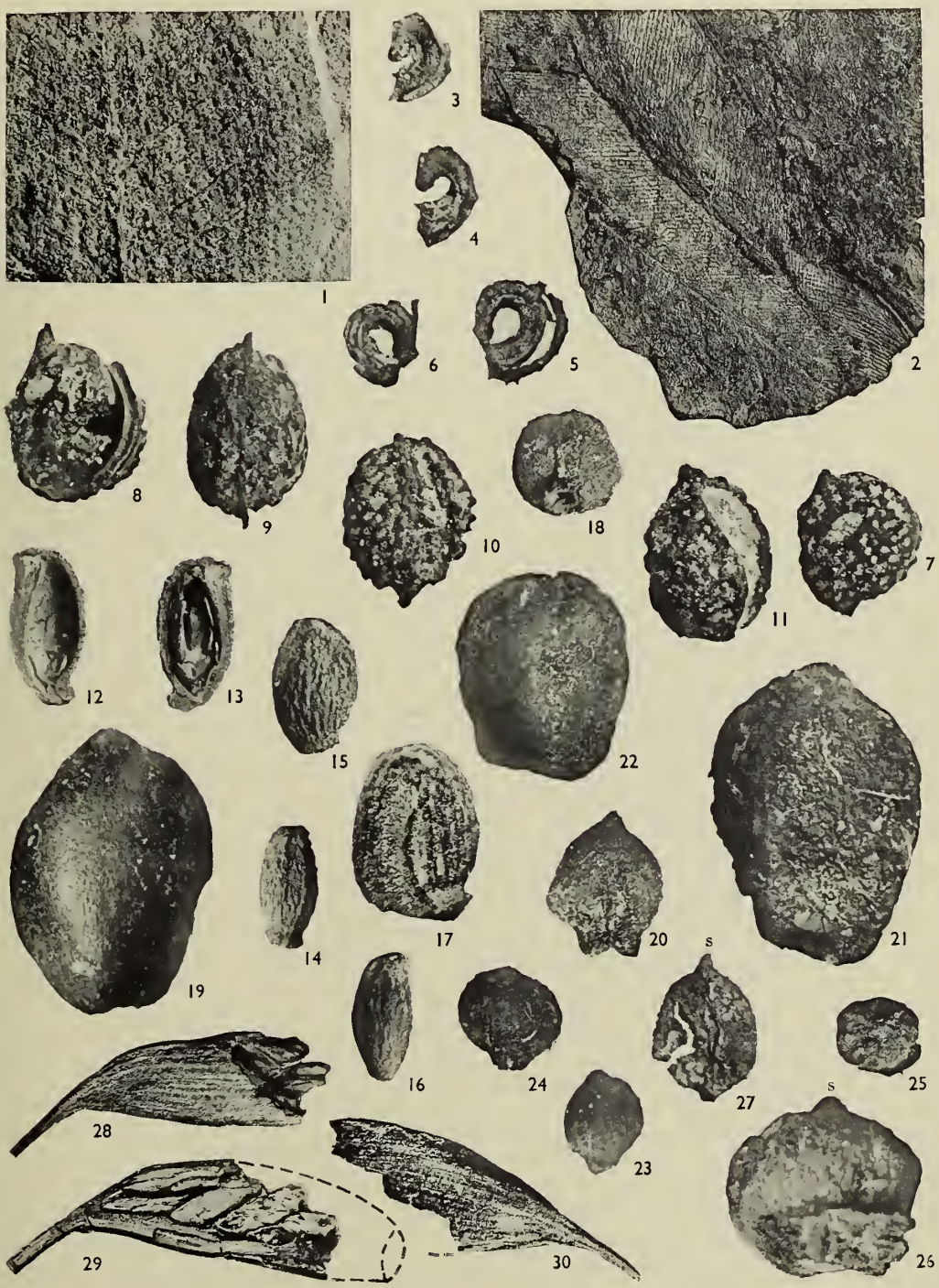
FIG. 27. Abraded fruit, side, (*s*) style. ×15. (V.42097.)

Spirematospermum headonense n. sp.

FIG. 28. Holotype. Fruit broken at stylar end so that seeds are exposed. ×1 approx. (V.42098.)

FIG. 29. Same with near wall removed to expose more of the seeds. ×1·3.

FIG. 30. Another fruit broken at stylar end from which seeds have fallen. ×1 approx. (V.42099.)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Spirematospermum headonense n. sp.

Fig. 31. Seed. ×9. (V.20037.)
Fig. 32. Seed. ×9. (V.42057*a*.) In matted mass of *Acrostichum lanzaeanum* said to come from Barton clay, Barton cliff.

Myrica boveyana (Heer)

Fig. 33. Endocarp abraded surface cracked along basal attachment and placenta. ×6·5. (V.42102.)
Fig. 34. Valve of another, interior showing locule and broad flat marginal suture. ×15. (V.42103.)

Carpinus boveyanus (Heer)

Fig. 35. Abraded fruit, (*b*) basal attachment scar. Longitudinal furrows due to calyx fibres are obscurely seen. ×15. (V.42104.)

Broussonetia rugosa Chandler

Fig. 36. Holotype. Endocarp slightly broken. ×15. (V.20039.)
Fig. 37. Another endocarp. ×15. (V. 20039*b*.)

Moroidea hordwellensis n. sp.

Fig. 38. Holotype. Fruit, side, (*st*) style; (*f*) funicle; (*ch*) position of chalaza within. ×15. (V.42105.)

Becktonia hantonensis n. gen. & sp.

Fig. 39. Holotype. Endocarp, side (bursting below), (*a*) subapical foramen for funicle. ×6·5. (V.42106.)

Hantsia pulchra (Chandler)

Fig. 40. Seed, side showing curvature, (*h*) rimmed hilum. ×15. (V.42107.)

Hantsia glabra n. sp.

Fig. 41. Holotype. Seed, side, smooth surface with finely toothed cells, (*h*) rimmed hilum. ×15. (V.42111.)
Fig. 42. Same, opposite side. Aperture of hilum (*h*) turned towards camera. ×15.
Fig. 43. Slightly distorted seed, (*h*) hilar rim (slightly incomplete). ×15. (V.42110.)

Brasenia oblonga Chandler

Fig. 44. Seed, side, longitudinal raphe on left. Tubercles well shown. ×15. (V.20043*a*.)
Fig. 45. Same, hilar end looking on to aperture from which embryotega has fallen. ×15.
Fig. 46. Holotype. Uncrushed seed. ×15. V.20043.

Palaeosinomenium obliquatum (Chandler)

Fig. 47. Holotype. Endocarp (*s*) stylar limb, elongate foramen (*f*) seen near stylar limb. ×6·5. (V.20049.)
Figs. 48, 49. Much broken valves of a second endocarp, (*st*) stylar limb. ×6·5. (V.20050.)
Fig. 50. Stylar limb of another endocarp showing ornamentation of marginal flange. ×15. (V.42122.)

Lauraceae, Genus ?

Fig. 51. Berry, apex (crushed dorsiventally) ×6·5. (V. 42123.)
Fig. 52. Same in longitudinal section showing conical endocarp with columnar wall, mesocarp represented by light coloured pyrites. ×6·5.

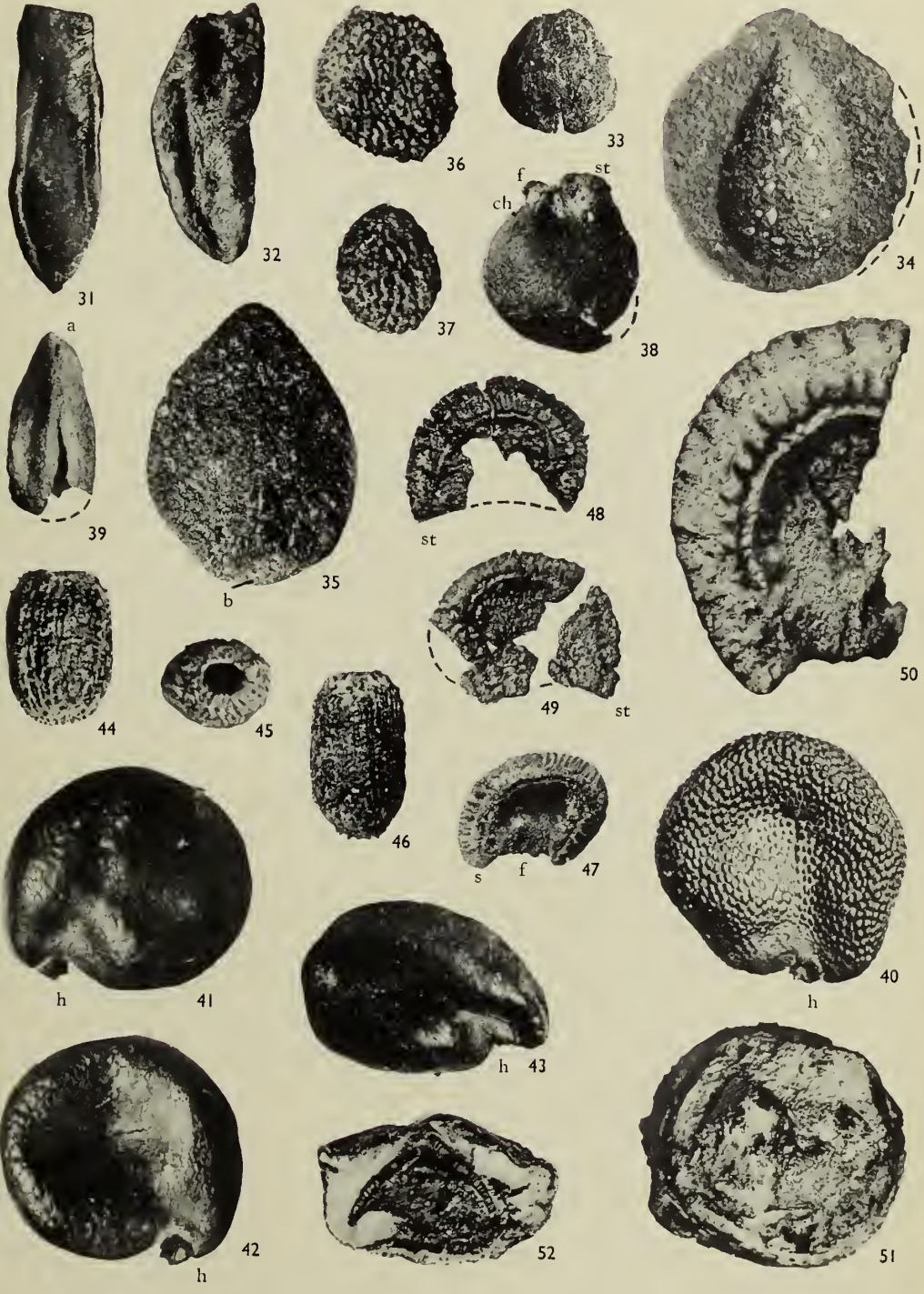
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PLATE 26

Aldrovanda ovata (Chandler)

FIG. 53. Seed showing long hilar neck, mucro at distal end, and longitudinal raphe ridge (on right). ×15. (V.42126.)

FIG. 54. Another with somewhat abraded surface. ×15. (V.42124.)

FIG. 55. Seed in longitudinal section showing prismatic cells within testa. ×15. (V.42125.) Colwell (presumed Lower Headon).

Eoliquidambar hordwellensis n. gen. & sp.

FIG. 56. Holotype. Mature fruiting head, base, showing areoles. ×2·6. (V.42131*a*.)

FIG. 57. Same, different aspect, showing a fruit (*f*) with two crescentic valves in an areole. ×2·6.

FIG. 58. Three areoles of same showing wrinkled shining epidermis over the valves of enclosed fruits, the evidence that they bore no awns. ×6·5.

FIG. 59. Immature fruiting head with areoles enclosing two-valved fruit apices. ×6·5. (V.42131.)

Protoaltingia hantonensis Chandler

FIG. 60. Much abraded fruiting head. ×6. (V.20054.)

LEGUMINOSAE, Genus ?

FIG. 61. Crushed seed. ×6·5. (V.43696.)

FIG. 62. Another genus. Hilum (*h*) associated with tumescent area. ×15. (V.43697.)

Zanthoxylum hordwellense n. sp.

FIG. 63. Holotype. Seed, side. Long hilar scar on right, (*ch*) position of chalaza. ×15. (V.20059.)

FIG. 64. Same, ventral view showing narrow-triangular hilar scar with orifice for raphe at its lower end. ×15.

Zanthoxylum compressum Chandler

FIG. 65. Holotype. Seed, side, short hilar scar on right. ×6·5. (V.20061.)

FIG. 66. Small area of same showing characteristic surface ornamentation. ×15.

FIG. 67. Another seed with abraded surface and shorter hilar scar (right). (*ch*) indicates position of chalaza. ×6·5. (V.42137.)

Rutaspermum ornatum (Chandler)

FIG. 68. Seed, broken on dorsal side, showing cell structure and surface ornamentation, also smooth area around hilar scar (right). (*ch*) position of chalaza. ×15. (V.42145.)

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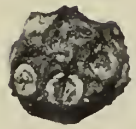

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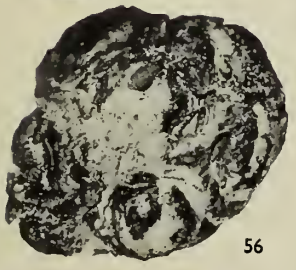

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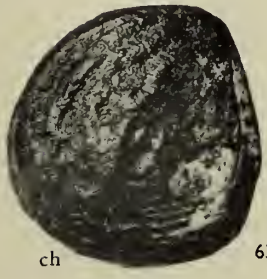

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PLATE 27

Rutaspermum ornatum (Chandler)

FIG. 69. Neotype. Seed, hilar scar to left. ×6·5. (V.42142.)
FIG. 70. Another slightly tilted to show hilar scar on right, smooth area around it clearly seen. ×6·5. (V.42143.)
FIG. 71. Smaller seed, hilar scar to left. ×6·5. (V.42144.)

ANACARDIACEAE SPONDIEAE, Genus ?

FIG. 72. Fragment of fruit showing sac-like, closely packed, secreting cavities exposed by fracture and abrasion. ×15. (Decayed.)
FIG. 73. Another fragment of same. ×15.

Palaeobursera lakensis Chandler

FIG. 74. Endocarp, ventral, (broken on left) showing cell structure. (*p*) Aperture leading to placenta. ×15. (V.42147.)
FIG. 75. Same, dorsal. ×15.

? *Iodes* sp. (or ? *Natsiatum* sp.)

FIG. 76. Funicular margin of an endocarp, (*st*) style. Funicular canal exposed below by a break in its outer wall. ×4. (V.20063.)
FIG. 77. Same, interior, (*p*) placenta. ×4.

Iodes ? *hordwellensis* n. sp.

FIG. 78. Holotype. Endocarp, apex, funicle on left. ×2·8. (V.42153.)
FIG. 79. Same, side, (*st*) style, funicle on left. ×15.

Icacinicarya transversalis n. sp.

FIG. 80. Holotype. Valve of endocarp, exterior (slightly imperfect), funicle on right, (*st*) style. ×2·8. (V.23420.)
FIG. 81. Same, interior, (*st*) style, funicle on left. ×2·8.
FIG. 82. Another distorted endocarp, broken at style (*st*). ×2·8. (V.23419.)

Icacinicarya becktonensis n. sp.

FIG. 83. Holotype. Endocarp, side, abraded at apex, funicle on right. ×6·5. (V.42155.)
FIG. 84. Same, apex, abrasion has exposed circular hilar scar (*s*) on seed within and part of funicle to right of it. ×6·5.

Frangula hordwellensis n. sp.

FIG. 85. Holotype. Pyrene, side, showing median longitudinal angle. (*p*) Fragment of outer pitted coat. Hilum at base. ×6·5. (V.42156.)
FIG. 86. Same, opposite, gently convex surface. ×6·5.

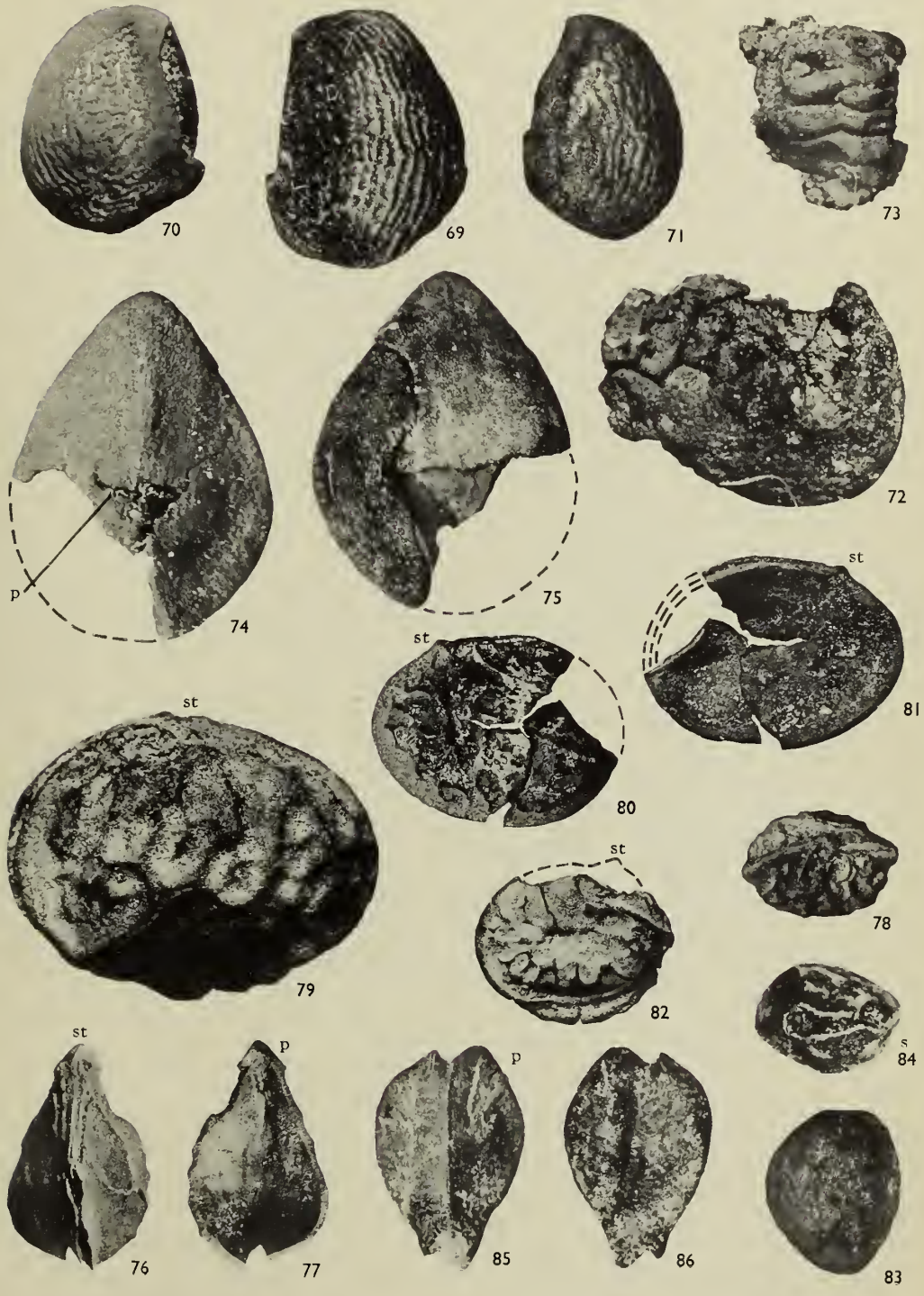
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PLATE 28

Frangula hordwellensis n. sp.

FIG. 87. Seed in figs. 85, 86 fractured longitudinally to show internal surface and (*h*) hilar depression; (*r*) marginal raphe; (*m*) micropyle; (*ch*) chalaza; (*rd*) ridge within hilar depression; (*t*) projecting testa forming rim around this depression. ×15.

Meliosma sp.

FIG. 88. Endocarp. (*a*) Attachment and funicular aperture. ×15·5. (V.42158.)
FIG. 89. Another somewhat broader specimen. ×15·5. (V. 42159.)

Parthenocissus hordwellensis n. sp.

FIG. 90. Seed, dorsal, with chalazal scar. ×6·5. (V.42161.)
FIG. 91. Same, ventral, showing long infolds. ×6·5.
FIG. 92. Another seed, dorsilateral. Chalaza on left. ×6·5. (V.42161.)
FIG. 93. Same, ventrilateral. Raphe ridge on left, facet with long infold seen. ×6·5.
FIG. 94. Poorly preserved seed, dorsilateral. ×6·5. (V.42237.)
FIG. 95. Same, ventral, with infolds. ×6·5.

Figs. 94, 95 from Horizon A3, Barton Beds, Highcliff for comparison.

Tetrastigma lobata Chandler

FIG. 96. Seed, ventral, showing lobing around infolds and raphe ridge. ×6·5. (Decayed.)
FIG. 97. Same, dorsal, showing sunk chalaza and radial lobes and furrows diverging from it. ×6·5.

Actinidia sp.

FIG. 98. Apical rounded end of a seed with pitted surface. ×15. (V.42165.)

Gordonia minima Chandler

FIG. 99. Fruit, lower end (upper part broken) tilted to show receptacle. ×6·5. (V.20070*a*.)
FIG. 100. Another (apex broken) tilted to show interior with broken central columella and bases of three valves below, lower end of two valves at *v*, *v*. ×6·5. (Decayed.)
FIG. 101. Fruit broken transversely showing five locules and septa. Valves triangular in section, columella at centre. ×6·5. (V.20071*b*.)
FIG. 102. Fruit broken above, sectioned longitudinally showing remains of columella and of two valves. ×6·5. (V.20071*a*.)

Eurya becktonensis n. sp.

FIG. 103. Holotype. Seed slightly broken dorsally. (*p*) Coarsely pitted thickening around hilum. ×15. (V.42168.)

Campylospermum hordwellense Chandler

FIG. 104. Fruit, side, with attachment and fruit wall remaining below. ×6·5. (V.20035.)
FIG. 105. Same (as seen from opposite side i.e. in longitudinal section) showing axis and a seed on each side of it. ×6·5.
FIG. 106. Detached seed from another fruit showing beautifully preserved cell structure of testa; (*h*) hilum; (*m*) micropyle. Irregular thickening of coarse cells is well seen in hilar region. ×15. (V.42170.)
FIG. 107. Neotype. Valve of seed showing curved cavity, (*m*) micropyle. Raphe in wall between limbs opening into chalaza at tip of shorter limb. ×15. (V.42169.)

Cleyera ? *stigmosa* (Ludwig)

FIG. 108. Seed, pitted surface poorly preserved. ×15. (V.42173.)
FIG. 109. Same broken irregularly longitudinally shows condyle between limbs of curved locule. ×15.
FIG. 110. Inner surface of fragment removed by fracture showing same features. ×15.
FIG. 111. Another. ×15. (V.42174.)
FIG. 112. Smaller seed. ×15. (V.42175.)


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Anneslea ? *costata* n. sp.

FIGS. 113, 114. Holotype. Seed, opposite surfaces, (*h*) hilum. ×15. (V.42177.)
FIG. 115. Another broken seed dissected to show condyle between curved limbs. ×15. (V.42178.)

Microdiptera parva Chandler

FIG. 116. Seed, dorsal with operculum partly detached but embedded in white matrix. ×15. (V.42182.)
FIG. 117. Same, ventral, showing median longitudinal body, lateral wings breaking away from it. ×15.

Mastixia ? *glandulosa* n. sp.

FIG. 118. Endocarp, dorsal surface with external longitudinal furrow. ×6·5. (V.42188.)
FIG. 119. Holotype. Endocarp, ventral surface. ×6·5. (V.42187.)
FIG. 120. Laterally compressed endocarp with ventral wall removed so as to expose inner surface (*i*) of dorsal infold projecting into locule. ×6·5. (V.42189.)
FIG. 121. Another with part of external wall removed showing solidified resin secretions (light coloured) occupying cavities in middle layer of wall. ×6·5. (V.42190.)

MASTIXIOIDEAE, Genus ?

FIG. 122. Endocarp, apex with two germination valves removed, the third which remains shows an infold at (*i*). ×2 approx. (V.20106*a*.)
FIG. 123. Same, side, one locule exposed by removal of a valve. ×2 approx.
FIG. 124. Upper part of the valve, inner surface showing infold. ×2 approx.

Dunstania glandulosa (Chandler)

FIG. 125. Holotype. Endocarp, broken at base. ×4. (V.20090.)
FIG. 126. Same, sectioned longitudinally showing two locules and resin cavities in walls. ×4.
FIG. 127. Neotype. Endocarp somewhat abraded, shows apex truncated by small depression. ×15. (V.42194.)
FIG. 128. Broader abraded endocarp with resin cavities partly exposed superficially. ×15. (V.42195.)

Cornus quadrilocularis Chandler

FIG. 129. Endocarp, side, apex excavated by small depression. ×6·5. (V.42193.)
FIG. 130. Same, opposite side with a valve partly removed showing locule, the ventral wall of which is broken at apex. ×6·5.
FIG. 131. Another endocarp, side, germination valve removed showing locule and apical depression. ×6·5. (V.20106.)
FIG. 132. Apex of same, three valves have been removed, one remains on left. ×6·5.
FIG. 133. One of valves removed, inner face. ×6·5.

Epacridicarpum headonense Chandler

FIG. 134. Fruit, base. ×15. (V.42197.)
FIG. 135. Same, apex. ×15.
FIG. 136. Valve of another, inner surface showing septum and two locules. ×15. (V.20083.)
FIG. 137. Same, side view, axis to left. ×15.

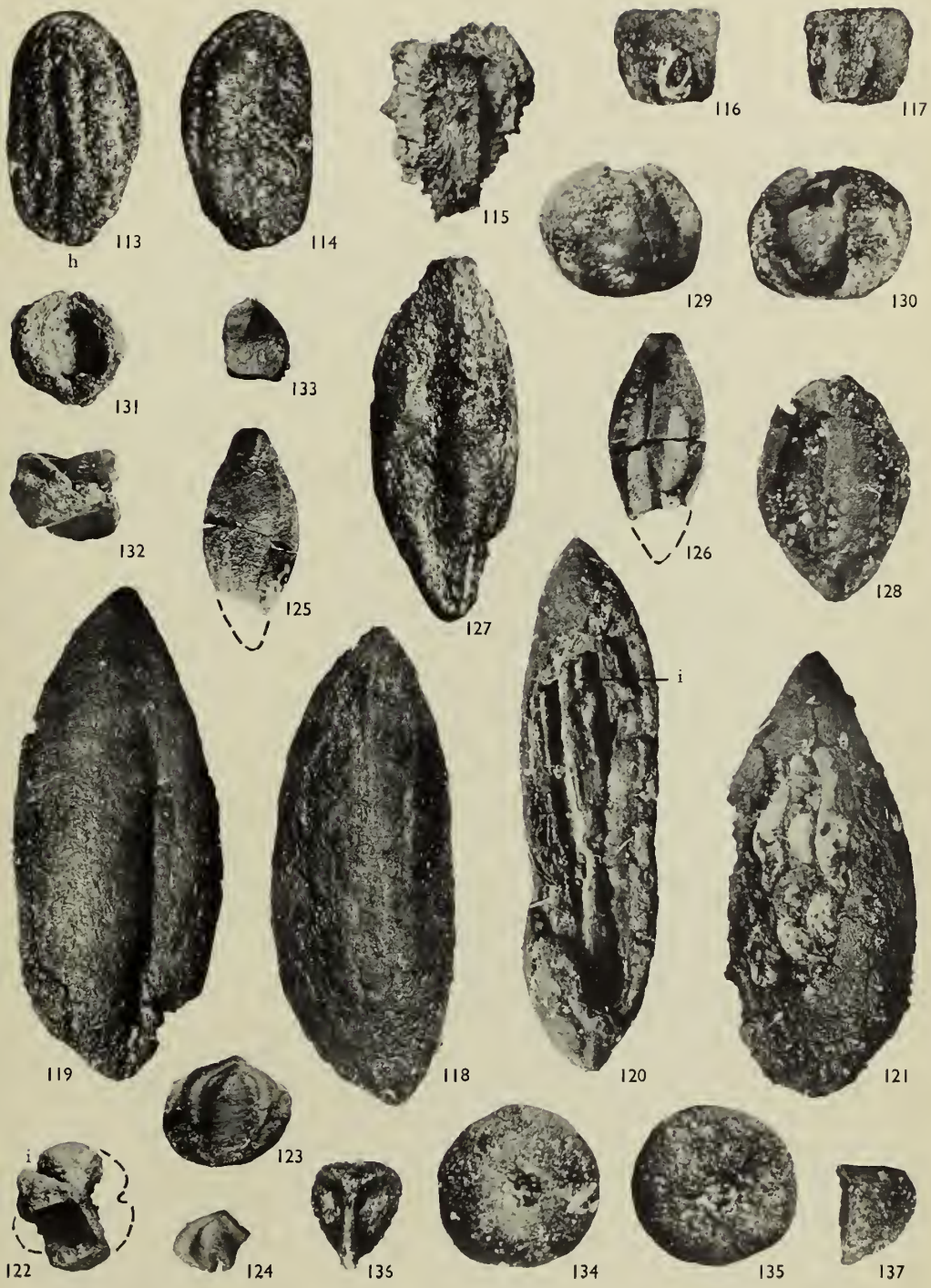
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PLATE 30

ERICACEAE, Genus ? sp. 2.

FIG. 138. Fruit, apex showing incipient splitting into valves. ×15. (V.42198.)

Symplocos headonensis Chandler

FIG. 139. Neotype. Endocarp, apex showing depression with four apertures to locules and a central aperture to axial canal. ×6·5. (V. 42202.)

FIG. 140. Endocarp fractured longitudinally showing two locules (filled with white matrix communicating with apical depression). Central canal exposed in upper part of endocarp. At apex behind it is the apical aperture of third locule. ×6·5. (V.42203.)

Olea headonensis n. sp.

FIG. 141. Small endocarp. (*a*) Attachment. ×6·5. (V.42208.)

FIG. 142. Holotype. Valve of endocarp which has split loculicidally. Locule with short oblique funicular canal (*f*). ×6·5. (V.42207.)

FIG. 143. Same, opposite valve, incomplete above, (*f*) funicular canal. ×6·5.

? *Acanthus* sp.

FIG. 144. Seed, side, (*h*) hilum. ×6·5. (V.42213.)

FIG. 145. Same, opposite surface showing characteristic puckering. ×15.

Cucurbitospermum reidii n. sp.

FIG. 146. Holotype. Valve of seed, exterior. ×4. (V.20098.)

Carpolithus apocyniformis n. sp.

FIG. 147. Holotype. Detached valve of capsule imperfect at distal end. Interior with median ridge representing remains of septum. ×15·5. (V.42224.)

FIG. 148. Valve of another capsule, outer surface. ×15·5. (V.42225.)

Carpolithus sp.

FIG. 149. Fruit with three styles. ×6. (V.20110*c*.)

FIG. 150. Fruit with three styles. ×6. (V.20110*b*.)

FIG. 151. Fruit with three styles broken on one side. ×6. (V. 20110*a*.)

FIG. 152. Four-loculed fruit sectioned transversely. ×6. (V.20110*e*.)

FIG. 153. Three-loculed fruit sectioned transversely. ×6 (V.20110*d*.)

Carpolithus sp.

FIG. 154. Six-lobed organ, lobes with slight transverse constrictions. ×6·5. (Decayed.)

FIGS. 155, 156. Another, opposite ends. ×6·5. (V.42229.)

FIG. 157. Recent specimen for comparison. Accidental impurity in seed packet from Yokohama Nursery Co. (unidentified). ×6·5.

Carpolithus sp.

FIG. 158. Valve of reniform seed, interior. Hilum between limbs. ×15. (V.42232.)

Carpolithus sp.

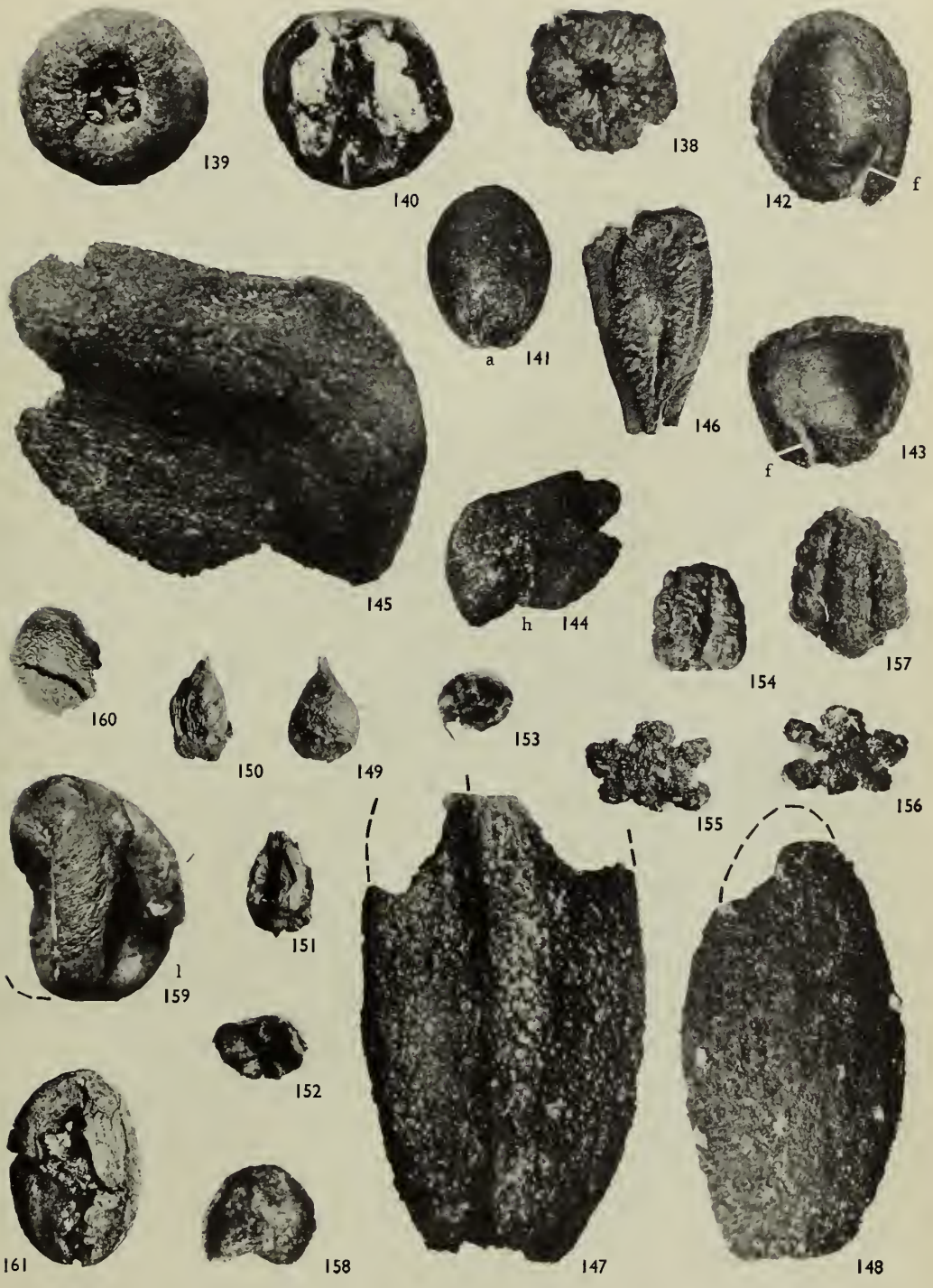
FIG. 159. Imperfect four-loculed endocarp. One valve faces camera but it is broken on left of median line exposing locule beneath it. Another abortive locule on left is not clear in figure; (*l*) is a third locule. The fourth is behind and out of sight. ×6·5. (V.42233.)

Tuber ?

FIG. 160. Organism with rough, scaley, cracking surface. ×6·5. (V.42234.)

Mastixicarpum crassum Chandler

FIG. 161. Endocarp, dorsal, breaking longitudinally along median infold. The transverse fracture showed C-shaped locule. ×2·4. (V.42235.) For comparison with Hordle material. Alleged to come from Barton clay, Barton cliff.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